RESEARCH AND DEVELOPMENT PROJECT
FOR
MODULAR WATER AND SEWERAGE SYSTEMS
AT
ROSE BLANCHE, NEWFOUNDLAND

THE DEPARTMENT OF REGIONAL ECONOMIC EXPANSION,
GOVERNMENT OF CANADA.

JANUARY 1974

Enviroclean Limited,
435 McNicoll Avenue,
Willowdale, Ontario.

RESEARCH AND DEVELOPMENT PROJECT
FOR
MODULAR WATER AND SEWERAGE SYSTEMS
AT
ROSE BLANCHE, NEWFOUNDLAND

THE DEPARTMENT OF REGIONAL ECONOMIC EXPANSION,
GOVERNMENT OF CANADA.

JANUARY 1974

PREPARED BY: G. Aldworth
R. Kargel
G. Clysdale
JM, FCH
LM, JS, RL

REVIEWED BY: R. Kargel
G. Aldworth

Enviroclean Limited,
435 McNicoll Avenue,
Willowdale, Ontario.

Enviroclean Limited
435 McNicoll Avenue, Willowdale, Ontario M2H 2R8
(416)-499-4544

6008

Mr. R. P. Harrison,
Director of Technical Services Branch,
Department of Regional Economic Expansion,
161 Laurier Avenue West,
Ottawa, Ontario.
K1A 0M4

Research and Development Project for
Modular Water and Sewerage Systems at
Rose Blanche, Newfoundland
Contract Ref. 1845

Dear Sir:-

An agreement between the Government of Canada and this firm was signed on September 11, 1973, and subsequently amended to August 23, 1973; whereby the Consultant agreed "to conduct preliminary engineering and to prepare physical definition drawings for water and sewerage systems for the community of Rose Blanche, Newfoundland."

We now take pleasure in submitting our report outlining the investigations carried out during the study and the resulting recommendations for modular water and sewerage systems. Conclusions and recommendations are presented in the "Summary" section of this report.

In accordance with the original intent of the project, innovative water and sewerage systems have been developed to service small communities at minimum cost. These aspects are discussed further on page S-10 of the report summary.

Mr. R. P. Harrison - 2.

Estimated capital cost, as tabulated on pages S-7 to S-10, is $687,900 for the entire works recommended herein (i.e. $392,500 for the water supply and distribution system only; and $295,400 for treatment and sewerage systems of Harbour le Cou and a portion of Rose Blanche). The estimated "operation and maintenance" cost for an initial 3-year monitoring period is $120,000. This is an important phase in a technology demonstration programme.

We wish to record our sincere appreciation for the co-operation and assistance provided us in this study by members of the Department of Regional Economic Expansion; Newfoundland and Labrador Departments of Municipal Affairs and Housing, and Provincial Affairs and Environment; Central Mortgage and Housing Corporation; and the Environmental Protection Service.

Particularly we wish to express our deep appreciation for the cordial assistance afforded by Messrs. R. B. Bowser, V. G. Ulrich, C, Karasek, J. Terpstra, D. Jeans, and Dr. C. J. Edmonds; and by Mr. A. Best, Chairman, Board of Trustees, Local Improvement District of Rose Blanche-Harbour le Cou, Newfoundland.

All of which is respectfully submitted.

Yours very truly,

G. A. Aldworth,
Group Manager, Technical Services.

RKargel:MS

INDEX

LIST OF FIGURES

LIST OF ABBREVIATIONS

CMHC - Federal Central Mortgage and Housing Corporation

DOE - Federal Department of the Environment

DREE - Federal Department of Regional Economic Expansion

MOE - Ontario Ministry of the Environment

MOT - Ontario Ministry of Transport

ORF - Ontario Research Foundation

EPA - U. S. Environmental Protection Agency

PE - Polyethylene plastic

ABS - Acrylonitrile-butadiene-styrene plastic

PVC - Polyvinyl chloride

fps - feet per second

c.f. - cubic feet

Igpd - Imperial gallons per day

USgpm - United States gallons per minute

("), in. - inch(es)

('), ft. - feet

BOD - Biological oxygen demand

SS - Suspended solids

Summary

As a result of the detailed studies and analysis performed during the course of this investigation, the following observations and recommendations relative to the development of innovative, modular water and sewerage facilities for Rose Blanche are presented.

1. Study Area

   The study area consists of Rose Blanche and its neighbouring community of Harbour le Cou. It does not include the existing development of Deadmans Cove.

2. Study Period

   This study has been based on developing and selecting optimum water and sewerage systems to serve the requirements of the study area to its ultimate development.

3. Land Use and Population Projections

   Areas to be serviced are entirely residential. The existing fish processing plant at Diamond Cove has its own water supply. The bait plant and partially completed herring processing plant in Rose Blanche are not included in the proposed servicing scheme. Stores, public and institutional buildings have been included. Areas for potential future development are indicated in Fig. No. 5.

   Population projections have been based on potential future residential development. The existing population has been derived on the basis of an actual house count and the assumption that the average occupancy rate is four persons per home.

Details regarding existing and future population are summarized as follows:

	Total		Harbour le Cou		Rose Blanche	
	Exist.	Future	Exist.	Future	Exist.	Future
Population	1,088	1,220	252	300	836	920
Homes	272	300	63	70	209	272

4. Water Consumption and Sewage Flows

The results are summarized as follows:

Consumption (Igpd)	Total		Harbour le Cou		Rose Blanche	
	Exist.	Future	Exist.	Future	Exist.	Future
Average Day	54,400	60,000	12,000	14,000	41,800	46,000
Max.-Day	136,000	150,000	31,500	35,000	104,500	115,000
Peak-Hour	272,000	300,000	63,000	70,000	209,000	230,000

Sewage flows have been assumed to be equivalent to water consumption, and on the basis of 102 homes to be serviced under the proposed scheme, the average daily sewage flow is anticipated to be 20,400 Imp. gal.

5. Standards

The potable water quality shall comply with the Canadian Drinking Water Standards and Objectives - 1968.

To protect the receiving water body, a secondary degree of treatment (removal of 90% BOD and SS) of the sanitary waste shall be provided.

6. Water Supply and Treatment

On the basis of preliminary field investigations of various alternative sources, Rose Blanche Brook is recommended as the potable water supply source.

The recommended water supply system consists of:

- a main pumping station and intake located at the Rose Blanche Brook.
- a ground storage reservoir located on a high plateau near Rose Blanche.
- a double transmission main interconnecting the main pumping station and the reservoir, and
- a booster pumping station located at the fork in the highway leading to Harbour le Cou.

(Integration of the existing fish plant supply with the proposed system is not practical).

On the basis of present knowledge, chlorination of the water only is being recommended. Subsequent to the development of water quality data by the Department of the Environment, this recommendation regarding water treatment will be re-evaluated.

7. Water Distribution

The supply to Rose Blanche will be by gravity from the ground reservoir through two separate loops.

Harbour le Cou will be supplied by gravity from either the transmission main or the ground storage reservoir, depending upon whether the main supply pumps are running or not.

The distribution system will be shallow-buried as far as possible, and protected with a styrofoam frost cover. Exposed portions of pipe will be insulated and wrapped. In addition, the freeze protection package provides for circulating heated water in the main loops during the winter season.

The recommended piping shall consist of heavy-duty polyethylene or ABS plastic to accommodate high pressure (up to 125 psi) and to provide robustness for burial under roads.

8. <u>Sewerage and Treatment</u>

It is recommended that a complete sewerage system be provided for Harbour le Cou and that only partial sewerage be provided for Rose Blanche.

The sewerage system proposed will be of the pressure type being fed by small grinder pumps, each serving one or two houses. Piping will be similar to that recommended for water distribution. It is suggested that pump maintenance be done by the town and that standby units be purchased for this purpose. However, electricity would be the responsibility of the householder.

The system being recommended for Rose Blanche consists of a special sewage pumping station to pick up the main common sewer. The sewage would be pumped to the treatment plant to be located in Harbour le Cou. In addition, some of the houses located along the force main would be collected as far as practical using the pressure sewer system.

The recommended sewage treatment plant to be located at the easterly portion of Harbour le Cou will consist of a package Bio-disc module capable of treating 25,000 Igpd. This package plant will provide for primary and secondary treatment of sanitary wastes. Wastes sludges will receive partial anaerobic digestion in a holding tank. The chlorinated effluent will be discharged to the sea via an outfall pipe.

It is recommended to monitor receiving waters for a period of three years to establish the benefits of treatment versus no treatment.

9. Fire Protection

It is recommended that self-contained fire protection be provided in the form of a mobile diesel-pump taking water from the sea or nearby pond or reservoir. In addition, a two-man portable unit (horizontal frame with handles), and a one-man portable unit (back-pack) could be provided.

It is noted that such fire protection apparatus will not be furnished with the water system.

10. Estimated Costs

A. Capital Costs

It is recommended that the capital works recommended herein be designed and constructed during the spring and summer of 1974 respectively.

The estimated costs are based on current 1974 prices with the existing Engineering News Record-20 Cities (U.S.) Construction Cost Index of 1940. Estimated costs listed hereinafter have not been escalated to the year of recommended construction and as such must be readjusted to the Index obtaining at the time of proposed construction. They are subject to further refinement on the basis of an estimate of the detailed design.

The estimated costs <u>do not</u> include for the following items:

- new water service lines between mains and buildings (existing lines to be used where possible)
- fire protection elements
- peripheral costs such as land, roads and electrical power service
- Federal sales tax
- costs for legal surveys to establish road right-of-ways, property lines, etc.

The estimated costs <u>do</u> include for the following specialty items:

- connection saddles
- line valves
- grinder pumps, discharge branches and existing sewer tie-in connections
- connection of main common sewer in Rose Blanche to proposed pumping station
- installation of the water and sewerage system in a common trench
- Provincial Sales Tax (7% on say 50% of capital cost)
- engineering design services and site administration of construction.

Estimated Capital Cost

	All Costs: Water Supply, Distribution, Sewerage and Treatment	Water Distribution Only	Sewerage Only
Main Water Pumping Station	$ 24,000	$ -	$ -
Water Transmission Line	47,300	-	-
Water Storage Reservoir Complex	38,400	38,400	-
Water Distribution:			
- Harbour le Cou	58,500	58,500	-
- Rose Blanche	163,000	163,000	-
Sewerage System:			
- Harbour le Cou	108,000	-	108,000
- Rose Blanche	54,300	-	54,300
Sewage Treatment Plant	87,000	-	-
Sub Total	$580,500	$259,900	$162,300
Prov. Sales Tax (7% on say 50% of capital cost)	20,300	9,100	5,700
Engineering design and site admin. services, and related costs @ 15%	87,100	39,000	24,400
Total	$687,900	$308,000	$192,400

Notes

- school in Rose Blanche assumed equivalent to 12 homes.
- unit cost per home under "all costs" provides partial sewerage only, approx. 33%.
- cost of grinder pump and discharge branch connection assigned to system, not to houseowner.
- trench costs for sewerage system are excluded, since the low-pressure forcemain is located beside the high-pressure water main in the same trench for thermal and capital cost reasons.

B. Alternative Schemes - Cost Comparison

	Modular, Shallow-Buried System		Conventional Deep-Buried System	
	Capital Cost	Unit Cost/ House	Capital Cost	Unit Cost/ House
All Costs: Water Supply and Distribution, Sewerage and Treatment	$687,900	$2,293 (1)	$1,745,600	$5,818 (1)
Water Distribution only	308,000	1,026	1,148,000	3,828
Sewerage only	192,400	1,886 (2)	258,400	2,533 (2)

Notes

(1) - accounts for partial sewerage only, approx. 33%

(2) - based on servicing the equivalent of 102 homes.

In the above table cost estimates for a conventional water and sewerage system serving Rose Blanche and Harbour le Cou are compared with those developed for the recommended modular system. As evident from the above figures, the cost for modular servicing is only approximately 40 per cent of that for a conventional system. These data clearly illustrate the cost savings that can be realized by a modular, shallow-buried system over those for conventional servicing.

C. Operating Costs

Estimated annual operating costs for the recommended modular and the conventional systems are as follows:

	Modular System	Conventional System
Fuel Oil	$ 2,800	$ -
Electricity	2,120	2,400
Chlorine	160	160
Operator	8,500	8,500
Sludge Disposal	2,400	2,400
Maintenance	6,000	11,000
Miscellaneous	2,520	4,940
Total	$24,500	$29,400

For the initial 3-year monitoring period it will be necessary to increase "O & M" costs to cover engineering services. Accordingly, it is recommended that an estimated cost of $40,000 per year or $120,000 total be budgetted for the initial period.

D. Summary - Capital and Annual Costs Per Home for Water and Sewerage Systems

A summary of estimated capital and annual operating and maintenance costs for the water and sewerage systems is presented in the following table. Also, the annual operating and maintenance cost per householder for each service is presented.

	Capital Costs	Number of Homes Serviced	Operating Costs per Annum
Water	$392,500	300	$12,500
Sewerage	295,400	102	12,200

	Cost Per House	
	Water (300)	Sewerage (102)
Capital	$1,308	$2,900
Operating Cost per Annum	$41	$120

11. Innovative Aspects

The research and development work under this project has led to a number of significant innovations, including the following main items:

a) Shallow-buried Pipes

Up to this time, virtually all municipal service lines have been deep-buried below the frost line to prevent freezing. This can be very expensive, particularly in rocky or hilly terrain. The modular system has shallow-buried lines with special heating insulation, and recirculation techniques to prevent freezing during Canadian winters - with a view to reducing capital cost significantly.

b) Pressure Sewers

Historically, sewers have been deep-buried gravity lines laid on continuous down slopes - an expensive proposition particularly in rocky hilly terrain. The modular system has special grinder pumps in individual houses, together with a common pressure sewer which is shallow-buried in the same trench as the water main and follows the general ground surface profile - thus being compatible with the shallow-buried water mains and offering considerable cost savings in rocky terrain.

c) Assessment of no-flow freeze times for water mains and pressure sewers under system breakdown or power failure conditions.

d) Development of important performance factors for pressure sewers including air scouring, vacuum breakers, and cleanouts.

e) New hardware applications for shallow-buried water system:

- Plastic piping (shallow-burial)
- Water heaters
- Recirculation arrangement, particularly the "co-current" design
- Pipe insulation
- Pipe frost-covers
- Bleeders
- Special mobile fire pump

f) Advanced hardware developments for pressure sewers:

- Small grinder pumps in individual homes. Such pumps represent the heart of a pressure sewer system, and are reputed to be clog-resistant and reliable. Rose Blanche will be the first large scale municipal installation in Canada, and operation will be closely monitored.
- Large grinder pumps for high-pressure low-volume service in a small community - suitable for higher static lifts and/or longer distances than presently available.

g) Sewage Treatment

A Rotating-Biological-Contactor (Bio-disc) treatment cell on municipal service having wide range of sewage flow and strength, together with low operating and maintenance requirements.

The operability of this relatively complex equipment in a remote community can be assessed under actual conditions.

12. Conclusions

The foregoing recommendations result from a research and development study of all factors pertinent to the provision of adequate water and sewerage facilities for Rose Blanche, and meet the objectives for innovative servicing at low cost.

1.0 General

1.1 Introduction

The need for reducing capital cost in servicing small municipalities is critical. Enviroclean's modular water system which evolved from recent research and development work for USAF by this firm shows great promise in fulfilling this requirement. Additional innovative development is essential to adapt the military Bare Base System to the municipal need, and a prototype installation is required to positively test such a system under actual working conditions over say a 3-year period.

Development work on the municipal application was initiated by the Department of Municipal Affairs and Housing of the Province of Newfoundland and Labrador where severe freezing problems had been encountered in existing systems of conventional design. Further, in the spring of 1973, DREE received a query regarding feasibility of installing a modular servicing concept for Rose Blanche, Newfoundland.

To ensure a reliable system compatible with low capital and operating costs, additional development has been done under this project on freeze protection for inexpensive shallow-buried pipe using innovative heating, insulation, and recirculation techniques; special materials for pipe subject to severe environment; tailored fire protection to obviate costly over-sized mains; advanced pressure sewer system to eliminate expensive deep excavations; and on certain related areas. At the same time, research on reliable treatment methods for sewage has been integrated into the project to provide complete and acceptable servicing for small communities.

The proposed modular water system for Rose Blanche as outlined hereafter is intended to meet these important and far-reaching needs.

1.2 Background

a) This project was intiiated by DREE in August 1973, and the terms of reference were to develop an advanced prototype system for a small Canadian community having the cold weather conditions and rugged terrain typified by Rose Blanche, Newfoundland. The eventual system would represent a cost saving over a conventional system, and would be closely monitored after start-up to assess its actual performance. Thus the project was conceived to service the needs of the community and to provide a prototype for demonstrating new technology.

b) An initial co-ordination meeting was held in Ottawa on 24 August 73, and attended by DREE, CMHC, DOE, and the consultant. The consultant was directed to assess Rose Blanche for general suitability.

c) The consultant visited Rose Blanche, and subsequently advised that it would be generally suitable for the intended purpose and a real test of the proposed system due to the rocky hilly terrain. Water supply would be provided for both Rose Blanche and Harbour le Cou, but sewerage for Harbour le Cou only - this being of adequate size to test the pressure sewer concept.

d) A second co-ordination meeting was held in St. John's on 14 September 1973 and attended by the above agencies plus the Newfoundland Departments of Municipal Affairs and Housing, and Provincial Affairs and Environment. The consultant was directed to prepare a draft report on a modular system for Rose Blanche.

e) The consultant revisited Rose Blanche for discussions with local officials and to investigate the details of the area.

f) The research and development work was done, a draft report prepared, and copies distributed to the involved parties for review.

g) A third co-ordination meeting was held in Ottawa on 11 January 74, and attended by DREE, CMHC, DOE, and the consultant. Comments on the draft report were reviewed, and the consultant was directed to finalize the report.

1.3 Items of Work Required to Meet Objectives

The detailed objectives for this project, as developed in the second co-ordination meeting, are summarized as follows:

1. Upgrade existing water system in Rose Blanche, and install new water system in Harbour le Cou; also provide the means for servicing new lots in the area.
2. Install new sewer system (including sewage treatment) in Harbour le Cou, and compare with those portions of Rose Blanche where existing sewers discharge directly to the sea without treatment - using appropriate monitors.

3. Assess suitability of modular servicing to rocky terrain and freezing weather, so this low cost system may be applied to other small communities in Canada.

4. Develop technique for adequate fire protection in communities of primarily residential nature, compatible with low cost servicing.

1.4 Standards

a) Potable Water Quality

The potable water quality (physical, chemical and bacterial) shall comply with the Canadian Drinking Water Standards and Objectives - 1968.

b) Sewage Treatment

As this project has far-reaching implications, treatment requirements were discussed in some detail with the Environmental Protection Service, Atlantic Region. It was concluded that a secondary degree of sewage treatment, removing 90 per cent of biological oxygen demand and suspended solids, would be an appropriate standard.

2.0 Basis of Preliminary Design

	Harbour le Cou		Rose Blanche		Total	
	Extg.	Future	Extg.	Future	Extg.	Future
Population	252	300	836	920	1,088	1,220
Homes	63	70	209	230	272	300
Consumption (Igpd)						
Average	12,600	14,000	41,800	46,000	54,400	60,000
Max. Day	31,500	35,000	104,500	115,000	136,000	150,000
Peak Hour	63,000	70,000	209,000	230,000	272,000	300,000

Notes

- Rose Blanche is primarily residential. Industry has not been included in the above design, i.e. the T. J. Hardy fish plant, the bait plant and the uncompleted herring plant, the former two having their own supply.
- Assume 4 people per home.
- Design criteria (based on practice established by the Department of Municipal Affairs and Housing of the Government of Newfoundland and Labrador):
  - i) Average consumption is 200 Igpd/home,
  - ii) Factor for max.-day - 2-1/2,
  - iii) Factor for peak-hour - 5.
- Supply system to be set up for "max.-day" condition, but distribution system for peak hour. Storage Reservoir capacity will be at least 33% of average day.
- For sewage treatment plant design, the organic loading is assumed as 0.17 lbs. BOD_5/capita/day.

The existing and future population (ultimate development) was discussed at a site visit to Rose Blanche with the Chairman of the Board of Trustees, Local Improvement District of Rose Blanche and Harbour le Cou. No accurate data appears to be available, but, based on an existing house count and the above assumption of 4 people per home, figures quoted by the Chairman for Harbour le Cou and Rose Blanche compare favourably with the existing population derived in the above table.

Prediction of future population for the ultimate development of the town is based on anticipated growth and land availability for development. The areas where future development could take place were outlined by the Chairman and are indicated on Drawing No. 5. Any re-settlement or expansion must comply with the Provincial Department of Health regulations. Permits only are issued when satisfactory water and sewerage facilities can be provided. For sewerage disposal, the Department requires provision of a septic tank with discharge of the overflow to the sea or a classified stream that terminates at sea. In the past, development may have been curtailed somewhat by the above requirements; however, with the provision of a piped municipal water supply, areas which heretofore had been restricted for development may now become available to support future growth.

It is recommended, therefore, that future growth be confined to areas marked as "future development" on Fig. No. 5.

3.0 Water Source

3.1 Source Alternatives

a) Frenchman's Pond

- present source for main portion of town
- immediately north of town
- quality is poor (drinking water is boiled)
- gravity supply in general (a few pumped supplies from pond).

b) Bridle's Pond

- not suitable, as this receives runoff from some "designated" brooks
- immediately east of town

c) Gull Pond

- west of Harbour le Cou and behind a very high ridge
- quantity and quality are probably good
- supply piping would be difficult due to long run, severe drop, and rough terrain
- gravity supply (+ pressure reducing)

d) Rose Blanche Brook

- approx. 1/2 mile west of Rose Blanche
- Brook has been dammed just north of highway, near its outlet to the sea.
- pumping station beside dam supplies fish plant
- drainage area is approx. 40 sq. mi., so quantity should be ample
- quality appears to be good
- pumped supply (from W.L. 7.5) is required

- supply main can be shallow-buried in the granular shoulder of the highway
- power supply is readily available
- it may be possible to integrate pumping facilities.

3.2 Recommendation

- On the basis of present knowledge, Rose Blanche Brook is the recommended source.

- It is suggested that the brook be monitored for quality, quantity, and temperature, by DOE. This should commence as soon as possible.

- Discussions with the existing user, the T. J. Hardy fish plant, should be undertaken to agree upon shared water usage of the recommended source.

- Other sources should be assessed on a general basis.

4.0 Outline of Proposed System

4.1 General

a) The modular system would be shallow-buried as far as possible to minimize capital cost and maximize physical protection. In the Rose Blanche area which is very rocky, this requires that pipes be buried in the granular road bed either beside or under the main road. This is not an optimum location as pipes under roads are more susceptible to freezing than those under ordinary ground, however it is somewhat better than the exposed situation. It is hoped that about 67% of the water system (i.e. water distribution and sewerage), can be buried. Paving of the new highway to Rose Blanche and Harbour le Cou was completed in the fall of 1973. Presently, the roads through the towns are unpaved; however, paving of some of these roads has been planned for the summer of 1974.

b) The system was designed to serve primarily a residential community. The existing large fish plant at Diamond Cove has its own fresh water supply which has a maximum capacity of 600 gpm. The existing small bait plant in Rose Blanche also has its own fresh water supply from a small pond above the plant. Its consumption is nominal and could be supplied by the proposed municipal system. The uncompleted herring processing plant in Rose Blanche does not have a fresh water supply. If this plant should be completed, and could process up to one million pounds per day of herring, the average consumption would be approximately 25 Igpm with peak demands reaching three times this value. It is unlikely that this plant will ever be completed since:

- the herring crop is dwindling, and
- adequate processing capacity is available at existing plants.

For these reasons, no allowance in capacity has been made to supply such a high uncertain demand, however the proposed water system could readily be expanded to meet such requirement.

The possibility of integrating the existing fresh water supply to the fish plant at Diamond Cove with the new supply to Rose Blanche was examined, and found to be unnecessary due to the general adequacy of the plant supply, and the large difference in capacity of the two systems.

c) Reference is made to the attached drawings for an appreciation of the proposed works:

- System schematics
- System layout

4.2 Water Supply and Distribution

Chlorinated water will be pumped from Rose Blanche Brook through a transmission main to a ground reservoir on a high plateau near Rose Blanche.

Services to buildings along the highway will be taken directly from the transmission main.

The supply to Rose Balnche will be by gravity from the ground reservoir through two separate loops. These will be circulated in winter only.

The supply to Harbour le Cou will be by gravity from either the transmission main or the ground reservoir, depending on whether the main supply pumps are running or not.

The water distribution system in Rose Blanche and Harbour le Cou will be shallow-buried as far as possible, and protected with a styrofoam frost-cover. Those portions exposed will be insulated and wrapped. The piping will be heavy-duty polyethylene or ABS to accommodate high pressures (up to 125 psi) and to provide robustness for burial under roads.

4.3 Sewerage

Harbour le Cou will be provided with a complete sewerage system.

It is proposed that Rose Blanche be provided with a special sewage pumping station to pick up the main sewer in town, and transport the sewage to the distant treatment plant in Harbour le Cou. The purpose of this limited system would be valuable in assessing new technology involving relatively large grinder pumps, lond distance pumping, and shallow-buried or exposed force main. Also, some of the houses located along the force main will be picked up as far as practical using the pressure sewer system. In the future, sewerage for the remainder of Rose Blanche could be provided on a similar basis.

The sewerage system will be of the pressure type being fed by small grinder pumps, each serving one house or possibly a cluster of buildings. Pump maintenance should be the responsibility of the town and standby units should be purchased for this purpose. However, electricity would be the responsibility of the householder.

Piping for pressure sewers will be similar to that described for water distribution. It is proposed to locate the low pressure sewer beside the high pressure water main in a common trench to keep costs to a minimum and to make use of heat carry-over from the water main thus keeping the sewer from freezing. Discussions with provincial authorities indicate that an 18" vertical separation between the water and sewer mains is desirable but not critical. A number of installations in U.S.A. have side-by-side pipes. It is noted that most Utilidors have the water main and sewer close together.

Further details are noted under Section 5 "Sewerage Considerations".

4.4 Sewage Treatment

Sewage treatment will be of the mechanical type, as the rocky terrain is generally unsuitable for lagoons. The proposed location is at the easterly end of Harbour le Cou and an outfall pipe will be provided into the sea.

The hydraulic sewage loading from Harbour le Cou is relatively low, but still suitable for the smaller package plants available commercially. It would be desirable to supplement the inflow by bringing in sewage from portions of Rose Blanche.

Disposal of digested biological sludge will be via landfill.

Further details are noted under Section 8 "Sewage Treatment Considerations".

4.5 Cold Weather Protection

The oil-fired water heater will be provided at the pumping station to increase the water temperature at the source. This is where it is most needed.

A second heater will be provided for maintaining water temperature in the ground reservoir. This will be the central heat-sink for the water system. A floating styrofoam cover will be considered to minimize evaporative heat losses. Additionally, the reservoir will be enclosed by an insulated wood building.

Water at 40 to 50° F. will be continuously circulated through area loops or half loops so as to maintain a warm environment and provide thermal lag during outages from power failure, equipment breakdown, etc. Special bleeders will be provided at the end of non-circulated branch mains to ensure some flow under conditions of low consumption.

Shallow-buried pipe in relatively dry soil will be protected by styrofoam frost-covers. Exposed pipe will be protected by polyurethane insulation with polyethylene wrapping.

Thermal carryover in the fluid will be utilized for warming the pressure sewers, and pipe protection will be as described above.

Where possible, the rate of circulation in water distribution loops should be in excess of peak-hour consumption, particularly when supply water is cold. However, this can be reduced to max.-day rate when supply water is warm.

Further details are noted under Section 6 "Freeze Protection Considerations".

4.6 Fire Protection

a) General

It is desirable to avoid the high capital cost of over-sized mains and large permanent fire pumps associated with conventional water systems, together with the attendant costs and operating problems of auxiliaries such as fire hydrants.

Although not specifically published, we understand that Canadian Underwriters' Association rate a municipality on a "point" basis as follows:

Water System	35
Fire Department	35
Accessibility (municipal roads, climate, etc.)	30
Total	100

With respect to small communities, some provinces require formal protection (per CUA) for over 600 lots, and intermediate protection in the range of 200 to 600 lots. Nominal protection is accepted for under 200 lots - for example, a fire truck connection at a well pumping station.

Recent thinking in the field suggests that heavy fire streams associated with large mains and hydrants are more suited to large industrial and commercial zones rather than residential areas. In fighting house fires, the heavy stream tends to agitate which is thought to be detrimental - and a fine spray which smothers by steam generation is more effective.

b) Representative Practice in Small Communities (Moosonee and Moose Factory, Ont. - total pop. 1324)

i) Water supply from hydrants

ii) "International" Pumper 625

Pump Rating:	625 Igpm @ 150 psi
	313 Igpm @ 250 psi
Hose Rating:	1600' of 2-1/2" std. fire hose (say eight 200' lengths).
	120' of approx. 4" non-collapsible suction hose (say six 20' lengths).
	300' of 1-1/2" high-pressure hose (or drum).
	2000' of 1-1/2" forestry hose (low pressure collapsible).

iii) Three portable forestry pumps (gasoline-engine driven) for grass fires, etc. approximately 110 gpm.

c) Proposed Rose Blanche System

It is understood that at present there is no self-contained fire protection in Rose Blanche - rather, pumper truck from Port aux Basques is available on demand.

It is proposed that self-contained fire protection be considered in the form of a mobile diesel pump taking water from the sea or nearby pond or reservoir. The trailer mounted pumping unit would have built-in priming capability, and a non-collapsible suction hose in say three 50' lengths of 4" diameter.

Discharge hose would be medium pressure (100 psi) collapsible vinyl-fabric hose in say four 300' lengths of 4" diameter, although a higher pressure rating may be required. The pumping unit (fire truck transfer pump) developed for the Bare Base project is rated 250 USgpm @ 260' TH, 50 BHP @ 1800 rpm, and is suitable for being towed by a jeep or truck.

In addition to the above, a two-man portable unit (horizontal frame with handles), and a one-man portable unit (back-pack) should be considered.

Appropriate nozzles would include a fog nozzle rated approximately 70 Igpm.

Further details are noted under Section 7 "Fire Protection Considerations".

4.7 Existing Installations

a) Water

It is proposed that the existing 2" Series 75 PE pipe in the Rose Blanche water distribution system be replaced or supplemented with new stronger pipe of the proper size. The existing pipe can be re-used where possible - possibly in the pressure sewer system which is relatively low pressure.

Apparatus within the existing pumping station such as pump and chlorinator will be re-used as far as possible.

b) Sewerage

Only one major common sewer exists in Rose Blanche serving 10 houses and the school.

The majority of houses have individual drains discharging to sea. In some cases 2 or 3 houses are connected to the same drain. More recently built houses have septic tanks with overflows discharging to sea.

In Harbour le Cou, houses are generally sewered individually and some have septic tanks which overflow to sea.

Generally, all houses in both communities have modern, indoor plumbing.

5.0 Sewerage Considerations

5.1 General

For sewerage in the Rose Blanche area, the following alternatives are notes:

a) Gravity: deeply-buried sewers below the frost line laid to grade - too expensive due to rock excavation.

b) Vacuum:

- Install "interface valves" in individual houses and a relatively large vacuum sewer in the same trench as water main (deeply buried).

OR

- Install vacuum toilets in individual houses and a relatively small vacuum sewer in the same trench as the water main (deeply buried). In this case, one would retain other fixtures such as washbasins and sinks, and dispose of this "grey-water" as at present - i.e. directly to the sea or to a designated brook or to a septic tank. This system would permit a very small treatment plant of the physical-chemical type.

c) Pressure :

Install grinder pumps in individual homes, or for clusters of up to six homes, and a relatively small pressure sewer in the same trench as water main (shallow buried).

d) Other:

i) Special toilets: chemical, incinerating, etc.

ii) Ground disposal:
- Septic tanks: generally unsatisfactory due to rocky terrain.
- Single-family household treatment systems such as Aquarobic (ORF/Waltech).

iii) Electrolytic household waste treatment unit.

iv) Direct trucking of sewage to disposal.

v) - Self-contained waste disposal systems such as Garrett Marine, Pacific Camp, Port-a-Built.
- Self-contained treatment schemes such as Liljendahl & Elsan-Yarrow.
- Multi-family complex treatment systems as recently developed by ORF.

The above techniques are identified for completeness, but are not generally applicable to Rose Blance.

e) Miscellaneous:

Partial recycle sewerage such as used at Point Barrow, Alaska. With water in short supply (probably delivered by truck), a utilidor was installed, comprising a gravity sewer, plus two heated flushing water lines - one supplying toilets and the other returning to the central heater. Flushing water make-up came from sewage plant effluent. This is worth noting, but is not really applicable to Rose Blanche.

5.2 Vacuum Sewerage

5.2.1 Some noteworthy installations

a) Trailers (mobile or permanent)

i) Fort Simpson, N.W.T.; in an "Atco" trailer; toilets, washbasins, etc. in the same enclosure as vacuum receiver tank and vacuum pump; DOE prototype facility for comparing vacuum and chemical toilets; vacuum is reported to be much more satisfactory.

ii) Baptist Church camp in Alberta; water shortage.

iii) Lake Ohara, Alberta (near Lake Louise); summer resort area; 35 toilets.

iv) Replacements for "Johnny-on-the-spot" units (about $7,000).

v) Used in shipyards.

vi) Bronte Creek Park, Ontario Ministry of Natural Resources; capable of accepting 2,500 flushes; no services available; special enclosure with cedar siding.

b) Marine

Tobermory Ferry; 37 toilets
DOE: 7 toilets on research vessel
MOT: retrofits on 7 vessels

Notes:
- This is presently the most active area of application in Canada.
- Feasible when there is a requirement for more than 3 toilets on a vessel; otherwise chemical toilets are used.
- Capital cost for supplying system elements is $1,570 to $3,000 per toilet (installation extra). Note that a toilet itself costs approximately $250.

c) Industrial

The vacuum system is suited to upgrading existing industrial plants with minimum disruption of operations (Pulp and Paper Co. in Mobile, Alabama, USA).

d) Municipal

i) Cox Bay, B.C.

- proposed system for new subdivision (about 40 homes).
- either one-pipe (black water) or 2-pipe system.

ii) Nepean Township, Ont.

- proposed system for an existing subdivision; 40 houses on septic tanks; combination problem; rocky terrain.
- System A: replace existing standard toilets with new vacuum toilets and connect to a one-pipe (black water) sewer installed in same trench as water main. Waste water from other fixtures (grey water) would still go to existing septic tanks. Cost estimate was reported to be 50% less than that for a conventional system (rocky terrain).
- System B: disconnect existing pipe to septic tank and insert a special interface valve in each home; install a larger one-pipe system in same trench as water main; 25% cost reduction claimed.
- Neither system has been installed. Home-owners objected to vacuum toilet of System A, and there were insufficient cost savings in System B.

iii) Killaloe, Ont.

- proposed prototype installation for town of 886 population by MOE.
- one-pipe system with interface valves for individual houses.
- This project has not been installed.

iv) Northwest Territories

- a prototype installation has been proposed in a Utilidor for this permafrost area. Utilidor becomes independent of continuous grade requirement.

v) Vancouver, Ont.

- trailer park.

vi) Denmark

- Town of Idestrup: 880 houses; largest system presently installed; vacuum toilets; one-pipe (black water) system; grey water to soil infiltration at individual homes; treatment of black water.
- Fed. Camping: 1800 persons; vacuum fixtures; two-pipe system; separate treatment for black and grey water.
- Lyngby Shopping Centre: very large (1,000,000 sq. ft.); vacuum fixtures; one-pipe (black and grey water) system; discharges into municipal sewer.

vii) Sweden

- vacation area having 273 cottages; 5 separate vacuum systems; shallow buried at 22", electrically trace-heated, insulated, and sand covered; capital cost of $440/house (with free labour); operating cost of $15/yr. per house (primarily truck haulage of waste water).

viii) United States

- Orange Co., Virginia

  proposed vacation area near lake having 4,000 lots; conventional fixtures; 13 separate vacuum systems; gravity flow from a cluster of four houses to a common collecting tank (1200 I. gal.) having interface valve; one-pipe vacuum system from valve to respective vacuum receiver tank; pneumatic ejector transport to a common sewage treatment plant of 200,000 initial and 600,000 IGPD ultimate capacity.

- Noorvik, Alaska

  (per G.W. Heinke, January, 1973)

5.2.2 System Aspects

a) A typical vacuum sewerage system provides for sewer runs up to 1/2 mile (i.e. 1 mile between receiver stations) and static lifts up to 15'. Supplier claims 6000' max. run when there is no static lift.

b) Operating pressures at receiver station vary typically from 16" to 21" Hg (roughly same as ft. of water). The extent of vacuum (say 21" Hg maximum) is related to commercially available vacuum pumps (Sihi or Nash) which are economical in cost.

For vacuum fixtures, about 12" Hg is required at the house branch. For conventional fixtures, the vacuum system must provide 5' for branch line and interface valve, say 10' for static lift, and remainder for sewer friction.

c) Interface valve, when used, is normally installed in valve pit outside house and below basement floor level. Conventional house fixtures in this system must be well vented to prevent sucking out traps.

d) Sewers are sloped two ways towards pockets at low points (say at 300' intervals) which are required to establish slug flow and prevent over-shooting.

e) Most sewers are of PVC pipe, solvent welded. In our opinion, ABS is preferable because of more reliable solvent welds and higher impact strength, However this material is not generally used for underground sewers due to higher material cost.

f) It is of interest to note that static lifts up to 90' have been achieved by lifting slugs progressively through a series of traps. However, there are complications, so this is not general practice.

g) Receiver stations cost $10,000 to $15,000 to supply and install.

h) Supplier generally furnishes special vacuum fixtures (or special interface valve) and all equipment within a receiver station.

5.2.3 Discussion re Municipal Application

a) Advantages

- Lesser installation costs due to reduced trench excavation. Pipe can be in the same trench as water main without the need for long continuous down-slopes, so the common trench can follow ground topography within limits of sloping to slug pockets.
- Lesser material costs due to using small piping in lieu of large conventional piping.
- With the use of the vacuum toilet, a saving in water consumption of up to 45 per cent is realized.
- More economical treatment of waste water due to greatly reduced capacity and high concentration of solids.

b) Disadvantages

- Restricted to low static lifts and relatively short runs.
- Mechanical complexity and functional appearance of vacuum fixtures.
- Mechanical complexity and capital cost of receiver stations.
- The system is sensitive to proper design (i.e. less forgiving).
- PVC piping is sensitive to proper installation.

- The constructed system needs proper operation and maintenance.
- Biological growths on interior pipe walls have been reported in the West Indies, requiring acid purging approximately once per year.
- Generally restricted to deep-burial in Canada for frost protection, although shallow burial may be feasible in the future. In such case, freezing susceptibility could be greater due to lesser water in the pipe and therefore lesser heat content. Development work is needed in this area.

c) Trends

For municipal applications in Canada; the vacuum system involving conventional house fixtures and interface valves at individual homes appears to be losing favour - probably due to mechanical complexity of valve, outside placement of valve in a pit (susceptible to freezing), and insufficient spin-off benefits (i.e. near-equivalent sewer sizes and flow volumes).

There appears to be growing interest in the vacuum system involving disposal of grey-water from conventional fixtures to a septic tank (where soil percolation is reasonable), and black-water from a new vacuum toilet to a receiver station via a one-pipe system of relatively small size. Waste water disposal from the station by tank-truck is more probable than physical-chemical treatment due to lesser complexity and costs.

5.2.4 Representative Capital Costs

Supplier advises that a study for a small community in Southern Ontario having 380 houses and pipe deeply buried in normal soil revealed the following:

i) One pipe (black-water) system including vacuum toilet and small branch line for individual houses.

. Sewers in same trench as water mains (i.e. trench cost excluded)	$750/lot
. Adder for portion of trench cost	250/lot
. Adder for sewage treatment plant	110/lot

ii) Two-pipe (black and grey water) system including vacuum toilet, interface valve and branch lines.

. Trench cost excluded	$1,260/lot
. Adder for sewage treatment plant	145/lot

iii) One-pipe (black and grey water) system including interface valve and large branch line.

. Trench cost excluded	$1,280/lot
. Sewage treatment (not applicable)	-

5.2.5 Closure

The vacuum system is less applicable to Rose Blance than the pressure system due to excessive pick-up distances, very high static lift requirements, and expense of deep-burial in rock.

5.3 Pressure Sewerage

5.3.1 General

a) At present, there are 310 pressure sewer projects - mostly in U.S.A. but some in Alaska, Japan, etc. The oldest was operational about 3 years ago. There appears to be no municipal installation in Canada at this time.

b) One project has 10,000 lots, but this is unusual.

c) Most projects have pumps in individual homes as this works out to be most economical for new sub-divisions. Note that a duplex unit could handle up to 6 homes. The situation could change if houses have existing sewer laterals. The pressure sewer system <u>fits</u> well with a modular shallow-buried water system as the <u>same</u> trenches and frost covers will accommodate both common mains and service lines. This "fit" is very important for projects involving both water and sewage.

5.3.2 <u>"Environment One" Grinder Pump</u>

a) . Pump is a progressing-cavity ("Moyno") type; rated 11 USgpm @ 35 psig discharge pressure, 1 BHP @ 1750 rpm; special grinder before pump element; single mechanical seal (ceramic and carbon) without seal water.

b) . Stator boot of neoprene; pressure balance design; projected life of 10 years in single family dwelling.

c) . Motor is conventional (at 1800 rpm), but with extended shaft and built-in thermal overload.

d) . Preferred power supply is 230/1/60 (4 wires). Alternative is 115/1/60 (3 wires).

e) . Two diaphragm level switches; captive air principle; tubing; one to start and stop pump (with 30 second time delay on both functions) and other to actuate high level alarm.

f) . Electirc motor and controls are floodable, but not submersible. Control chamber must be properly vented above max. hyd. gradient. Ground water is main offender (not sewage), particularly when gasketting has been abused during servicing.

g) . Special check valves (2-in-series) are disc weighted rubber flapper type of "Environment One" design.

h) . Syphon-breaker valve (on branch upstream of first check) is same valve but installed in reverse direction. It is important in preventing syphoning of sump through pump into a force-main which may be under vacuum under certain conditions.

i) . The grinder, constructed of hardened stainless steel, consists of a rotating wheel carrying two hammers, and a stationary cutting ring. It is designed to achieve a small particle size - about 90 percent will pass a 0.25-in. sieve and virtually all will pass a 0.5-in. sieve - to minimize problems due to clogging of pump and pipe line. It is reported to be capable of handling foreign objects such as plastic, rubber, cloth, wood, or even some metals. Operability has been substantiated in a field demonstration supported, in part, by the U.S. Environmental Protection Agency.

j) . An overflow is provided with each unit to prevent flooding in case of an extended power failure, or any breakdown in pump or system.

k) Reliability: Manufacturer advises as follows:

Servicing - once every 3.9 years
Overhaul - once every 10 years

5.3.3 Alternative Grinder Pumps

a) "Nayadic Sciences Inc.", Penna.
- similar to "Environment One" design.

b) "Hydr-O-Matic" USA (F.P. Myers, Kitchener, Ont.)
- centrifugal type.
- 22 USgpm @ 80' TH, 1-1/2 BHP @ 3500 rpm
- submersible oil-filled motor
- special tungsten-carbide grinder
- $1,100 each.
- on the market over 3 years; 50 to 100 units in Louisiana and Taxas; one in Elmdale, N.S.; one in Ganonoque, Ontario.

c) "H & B Ind. Div. Robiutech" Tulsa Unit, 10 USgpm @ 80' TH, Fort Worth, Texas.

In reviewing the alternatives, our preference is for the "Environment-One" progressing-cavity unit due to superior performance (low flow at high head), slower speed (1750 vs 3500 rpm), ability to momentarily increase discharge pressure to say 45 psi, better track record, better safety (motor not submersible). It is now at the fourth-generation level in development, and has been given C.S.A. approval.

5.3.4 System Cost Aspects

a) . In reasonable soil (granular, clay, etc.), costs are roughly the same for deeply buried gravity sewers and for pressure sewer systems. These work out to about $1,500/lot. (Note that this assumes trench cost for the pressure sewer is excluded because the pipe is in the same trench as the water main or service line). It is evident that a gravity sewer would always be chosen over a pressure sewer unless there are extenuating circumstances.

b) . For unreasonable conditions (rocky terrain, high water table, undulating surface profile, etc.), there is a case for the pressure sewer as costs can be significantly less.

c) . List prices of grinder pump packages in U.S.A. (increase 20% for retail):

GP - 210 - $1,000 (std., one house)
- 212 - $1,200 (larger tank, 2 houses)
- 214 - $1,900 (duplex pumps, up to 6 houses)

These unit prices can be reduced for bulk orders. Note that a truck-load constitutes about 90 standard units.

d) . Installed costs for individual houses:

		In Rock	In Normal Soil
i)	Gravity: lateral deep buried, 4" dia. x 60' long	$1,200/lot	$ 240/lot
ii)	Pressure: 2 houses on 1 pump, outside installation in a pit, laterals deep-buried (4" dia. x 30' long) disch. br. shallow-buried (1-1/4" dia. x 60' long)	1,195	1,005
iii)	Pressure: 1 house on 1 pump, basement installation, disch. br. shallow-buried (1-1/4" dia. x 60' long)	1,300	1,240

It is general practice in pressure sewer schemes to use alternative (iii) (1 house on 1 pump) rather than alternative (ii) even though the cost is slightly higher due to the obvious advantage of interior location and single home owner responsibility.

This is recommended for Rose Blance, except where the drain from a house at higher elevations can be run into the basement of a nearby house at lower elevation. In this case, one pump with a larger sump can serve two houses.

5.3.5 System Design Aspects

a) - Avoid "loops" in pressure sewers. Build them up like branches on a tree.

b) - Size forcemains for 1-1/2 to 5 fps to avoid depositions. Deposition problem may be over-emphasized as "Environment One" has tested 16 USgpm through 3" dia. pipe (V - 0.7 fps), and ground solids readily re-suspend on start-up. (Flow regime is still "turbulent" at this low velocity.)

c) - Required velocity for scouring air in pipelines:
- Kent's formula:

$$V = 1.24 \sqrt{gD \sin\theta}$$

V - scouring vel. (fps)
D - pipe dia. (ft.)
θ - down slope (°)

(e.g. 3" pipe with 10° down slope requires V = 1.45 fps or Q = 32 USgpm)

d) - Air release valves do not appear to be critical. The EPA prototype system at Grandview, Indiana for approximately 100 homes had a 15' high hump at one location. A pressure recording shows a pressure build-up of about 15 psi during low flow periods (week-ends, etc.). However, this clears during normal flow conditions and pressure reverts to normal. It is important, however, that pumps have adequate pressure build-up capability to purge such humps, and a velocity of at least 2 fps should be achieved each day for pipe sizes up to 6" dia. and down slopes up to 10%.

e) - Negative head conditions are possible in a forcemain having a relatively low discharge point. Ordinarily, this is not critical as syphon-breaker valves on individual pumps open up. If it is a weighted check valve near the forcemain, discharge is possible, but ensure that nearby pumps are not over-pressured.

5.3.6 Proposed System

Reference is made to Fig. No. 3 "Schematic of Pressure Sewerage System" showing the proposed set-up for the Rose Blance area.

A grinder pump will normally serve one house, although it will serve two houses when they are close together and there is a significant elevation difference. Where possible, it will be situated in the house basement as a free-standing package, as shown in Fig. No. 4. Where there is no basement, it will be located preferably under the first floor and protected by an insulated wood enclosure. Exposed pipes must be insulated for this latter case.

A small inexpensive bleed fixture rated approximately 1/20 gpm will be incorporated into the plumbing system of each house. This should be turned on in very cold weather before going to bed, and turned off on rising.

Discharge branch will be of 1-1/4" PE, and shallow-buried when possible in the same trench as the water service line.

The forcemain will be of 3" PE, and shallow-buried when possible in the same trench as the water main. Its profile is such that an air release manhole should be provided at the system's high point. Where possible, down slopes should be limited to 10° max. so as to facilitate air scouring (i.e. 3" dia. and 10° max. down slope requires V = 1.45 fps or Q = 32 USgpm). Combination cleanout-scouring stations should be provided at intervals.

The high perssure pumping station in Rose Blanche will discharge to the high level manhole. It will be possible to pick up en route the discharge branches from those houses situated above grade el. 125, thereby staying within the grinder pump pressure rating of 35 psig or 81'.

5.3.7 Closure

Pressure sewerage is the recommended system because of its general suitability for rocky terrain and high lifts, plus its desirable fit for the shallow-buried configuration.

6.0 Freeze Protection Considerations

6.1 General

The protection of water pipes from freezing is customarily achieved by burial to a depth below the 32° F. isotherm penetration, the so-called frost line. Where this is possible, it has obvious advantages.

Where such burial is, for some reason, not practical because of very deep frost penetration as in permafrost areas, "Utilidor" enclosures, supported well above the ground by wood posts, have been used to house water mains and sewers. Heat loss is minimized by insulating the pipes or the Utilidor itself. Heat addition is by recirculating the water through a central heater (often an oil fired boiler) or by tracing the lines by electricity. Such systems are optimal for permanent Arctic installations such as Alert N.W.T. where their relatively high cost can be justified.

The means evolved over the past few years for dealing with unburied pipe in large military installations and shallow-buried pipe in small municipal applications will serve as a basis for the Rose Blanche project.

6.2 System

The principle followed is to raise the temperature of the water supplied to the system to a temperature of, say, 40 to 50°F, and to arrange the piping layout so as to permit continuous circulation within the system. Thus, by an appropriate choice of circulation rate and preheat temperature, the water in the return line part of the system can be kept well above 32°F. The returned water is reheated and recirculated. Even when there is no water being drawn from the system, there is circulation in the mains and the water cannot stagnate, cool and freeze.

Where complete recirculation is uneconomic, such as in serving a single user several hundred feet from the main loop, a single small branch line can be protected from freezing by maintaining a small, fixed rate "bleed" or spill from its outer end, or alternatively by heat tracing the line with electric heating cable and insulation.

6.3 Insulation

In order to keep the initial and operating costs for the water heaters at a reasonable level, and the required circulation rates moderate, the provision of some form of thermal insulation is necessary. In an above-ground application, this takes the form of fitted pipe insulation of a type having suitable thermal insulation and physical strength properties, and protected from weather and wear by an appropriate jacket.

Locations which may be deeply snow-covered in winter are favoured since the snow adds to the insulating effect, and long stretches unprotected from the wind are clearly undesirable.

Unburied pipe should be avoided where possible because it will freeze in a relatively short time if the circulation of the water is, for any reason, interrupted on a cold day. The thermal inertia of the pipe and water is low and it rapidly cools to the freezing point. Even with thick insulation, freezing will begin on a 0°F day within a few hours in an exposed small pipe.

Shallow burial to a depth of, say, 2' will offer a very much longer permissible stagnation time following a system breakdown as compared to exposed pipe. Safe times of two to eight days are typical for a system in which the water was at 40°F before the breakdown, even in zero weather.

6.4 Frost Covers

Thermal insulation of the pipe is less critical in shallow-burried installations since the heat loss is normally lower, especially in dry soils or gravel. In such locations, expensive pipe insulation can be avoided and adequate retardation of heat flow provided by a slab of rigid insulation laid above the pipe. This installation has the advantage of raising the temperature and stored heat in the earth adjacent to the pipe and thus attenuating the freezing period.

Where buried pipes are below the water table, or very close to the surface, fitted pipe insulation will be required.

6.5 Exposed Piping

An unburied pipe system should be supplied with drainage positions which will permit draining the system if a circulation breakdown cannot be repaired before freezing begins. In a system with exposed pipe, this would require drainage within a few hours. Once frozen, it may be impossible to thaw such a system before the spring, but a drained system can be restarted sequentially if proper care is exercised.

6.6 Comparison With Utilidor System

As described in Section 6.1, the utilidor is best suited to permafrost areas where below-ground installation of pipes is not practical due to sub-freezing temperature and general soil instability. Basically, the utilidor is a box structure fabricated of wood, aluminum panels, or corrugated pipe. Usually it is set well above ground on piles; in some special cases the utilidor may be located on ground resting on wood sleepers. The box, in each case, is insulated and carries all services - water main, sewer and, as at Inuvik N.W.T., central heating. Service connections are accommodated in utilidettes which are similar in construction to the main utilidor. Construction costs vary widely, ranging from $50 to $300 per foot of utilidor. For a utilidor of average design, present costs might be in the order of $120 per foot.

The modular system described herein would apply to small communities that are not within the permafrost zone. The design concept for the shallow-buried pipe system recommended in this report is completely different from that of a utilidor system resulting in very much lower material and labour costs. An approximate average cost per foot for the shallow-buried water and sewerage systems is in the order of $12 per foot.

7.0 Fire Protection Considerations

7.1 General

Fire protection for a community can be provided by a number of methods, and to various degrees of protection. The two main methods of fire protection services are the use of a water supply system (hydrants), and the use of static water sources (i.e. a pond, lake, river, or water reservoir) to be either pumped directly to the fire, or into a tank truck for delivery to the fire. Pumping directly to the fire can be from a permanent pumping unit, or a mobile unit which can be moved from site to site, and source to source as required.

Although the total fire demand on a water system is small, the rate of water demand during a fire is high, often well in excess of the peak domestic water consumption which the water system would otherwise deliver. Because of the excessive costs involved in oversizing the components of a small water system, and because of the relatively dispersed development and general lower property values in a small community having minimal industrial and mercantile developments, it is generally not economical to provide fire fighting capacity in the water system.

A number of regulatory and interested agencies were contacted to discuss policies and general practices in the area of fire protection.

7.2 Regulatory Bodies

a) Canadian Underwriters Association

The standards of the Canadian Underwriters Association have been recognized and accepted as the authoritative standard in municipal fire protection in Canada. This Association evaluates communities for fire insurance rate calculations. Since the Association is a national body, the required standards are virtually identical across the country. Accordingly, the local office (Toronto) of the Canadian Underwriters Association was contacted for discussion.

Although the Association would prefer to have fire protection capability in the municipal water distribution system, they realize that such is not always possible, especially in smaller communities. Without evaluation of any specific community, the Association feels that the rates for insurance with a volunteer fire department would be about the same with fire water supplied from either the water distribution system or a nearby static source (pond, sea, etc.). The two possible concerns with a pumped system were the questions of ice cover during the winter and the corrosive effect of salt sea water on the pumps. However, it is evident that efficient portable ice augers are available at reasonable cost, and that pumps capable of handling sea water are readily available.

The required standards for a small, residential community are much lower than for a large urban area having significant industrial and commercial areas.

b) Newfoundland Fire Commissioner

We understand that the Province of Newfoundland and Labrador has recently commissioned a task force to examine the overall question of fire protection for small communities. A copy of the report has not yet been reviewed, but the office of the Fire Commissioner was contacted for a general discussion on fire protection.

The Commissioner's feelings are that the water system should be provided with capacity for either domestic and fire flow, or domestic use only - with fire protection being from some other source. The main concern with using the water system as a source for fire fighting water appears to be the problem of high capacity fire pumping units taking suction from low capacity mains. On the other hand, with a water system for domestic use only, a 500 I. gal. tank would be adequate. A concern with using a pump from a static water source is that the source must be reasonably accessible to the pumping unit.

c) Newfoundland Department of Provincial Affairs and Environment

The Department is responsible for the approval of water and sewerage systems in the Province. However, discussions with senior staff indicated that the Department has no jurisdiction over fire protection requirements for a municipal water system.

d) Ontario Fire Marshall

The Ontario Fire Marshall's office was also contacted. This group concedes that, although desirable, provision of fire fighting capability from a municipal water system is not always feasible. Providing it is accessible year round, a static water source feeding a fire pump, or a tank truck can give adequate fire protection.

e) Ontario Ministry of the Environment

Although not directly involved with fire protection, the MOE Design Approvals Branch is responsible for approving all water systems prior to installation.

The Ministry feels that fire protection capacity does not have to be provided in a municipal water system. However, some additional capacity for fire protection systems is often requested by a specific municipality.

Although each municipality must be judged separately, general practice is that a community with 300 to 400 lots is predominantly a low density residential development, with little high value industrial or commercial development, and has minimal fire protection from the water system. Larger communities, having higher value industrial and commercial development, require a higher degree of fire protection. The Ministry feels that the requirements of the C.U.A. tend to be conservative and that adequate fire protection can often be provided by lower standards. Another consideration is that, for a poorly looped grid system, a small water system sized for full fire protection could have stagnant water - an undesirable side effect.

7.2.5 Summary of Practice

i) All agencies prefer full fire fighting capacity in the water distribution system, but acknowledge that this is not always feasible - particularly for small water systems.

ii) Acceptable fire protection can be provided from a static water source (lake, pond, river, etc.) supplying either a fire pumper truck or a tank truck. The main concern is that the source must be readily accessible year round.

iii) In general, the fire protection requirements are lower for a small low density residential community than for a larger urban center having higher value industrial and commercial developments.

iv) The standards of the Canadian Underwriters Association are set as desirable guidelines, but in practice are often only partially provided, especially in smaller communities.

7.3 Fire Fighting Requirements for Rose Blanche

A brief review of the Rose Blanche area as it relates to fire protection is outlined as follows:

i) Small dispersed residential community of about 1,100 people generally developed in several clusters in the harbour areas along the shoreline, and connected by recently improved roads.

ii) The fish processing plant is geographically isolated from the development, and has its own water system.

iii) There are a number of ponds as potential sources for fire fighting water plus, of course, the inexhaustible supply of the sea.

The required fire flow is well in excess of the peak domestic flow. Providing a water system capable of both fire and domestic flows requires major increases in the system components. To illustrate this point, a cost analysis was prepared for a modular, shallow-buried water distribution system including fire protection. Results of this study are presented in Appendix A, Section A.4. Therefore, it does not appear to be feasible to provide fire protection capability within the water distribution system. The choice is between direct pumping and pumping to a tank truck.

A study of available mapping in the Rose Blanche area indicates that there is a large number of ponds, in addition to the proximity of the sea. Most buildings are within 300' of such sources, and all are within 600', which is not unreasonable. Because of the proximity and abundance of water, it appears that a tank truck would not be required, and that fire protection could be provided by a mobile pumping unit.

The maximum elevation difference between a source and a residence is about 80', which again is not unreasonable.

7.4 Equipment

a) General

Fire fighting equipment can be considered in three basic components - nozzles, hose and pumps. Reference is made to Subsection 4.6 for equipment details, and some supplementary aspects are noted as follows:

b) Nozzles

Fine spray is obtained by use of fog nozzles in 1-1/2 and 2-1/2" sizes. Typical discharges for these nozzles at 100 psi are 70 and 110 I.gpm respectively. It is noted that nozzles require a minimum of 45 psi pressure for effective operation.

c) Hose

The typical fire hose requirements are compactness (for easy transport), flexibility (for use on uneven ground), and high pressure capability.

d) Pumps

A pumping unit must include an ice auger or other devide for easy ice removal and required fittings and clamps. The trailer must have the capacity to carry the required fire hose and other equipment.

8.0 Sewage Treatment Considerations

8.1 General

The complete sewage treatment works will include a waste water treatment process for the removal of BOD, and suspended solids, chlorination facilities for disinfection, and an outfall sewer for final disposal of the treated sewage to the ocean. A number of different biological sewage treatment facilities, including activated sludge plants, rotating biological contactors, trickling filters, and lagoons are considered as treatment alternatives for Harbour le Cou (and possibly Rose Blanche). Additionally, advanced physical-chemical plants will be considered.

The main criteria used in evaluating the treatment processes are ease of operation, extent of mechanical equipment (reliability), capital and operating costs, and the degree of treatment provided. A secondary level of treatment, i.e. about 90% removal of BOD and suspended solids is considered appropriate.

At the present time, there are about 272 houses in the Rose Blanche area - 63 in Harbour le Cou and 209 in Rose Blanche, and a total population of 1,088 people. Projected population in future is noted under Item 2.0. It is proposed that all 63 houses in Harbour le Cou and the equivalent of 39 houses of those in Rose Blanche be served by the sewage treatment plant. Therefore, a 25,000 I.gpd capacity will be ample for the demonstration plant intended.

8.2 Sewage Treatment Alternatives

8.2.1 Non-mechanical Alternatives

a) Standard Facultative Lagoons

Assume: 1 acre/8000 Igpd
Repr. capital cost for 25,000 Igpd lagoon
- 3 acres @ $5,000 per = $15,000

b) Aerated Plus Standard Lagoons

Assume:
- two cells, first aerated for 65% reduction of BOD and second standard for 35% reduction;
- total size and cost of cells equal to 50% that of a standard lagoon;
- size of aerated cell limited to 5 days retention due to freezing;
- floating aerator @ 3 BHP

Repr. capital cost for 25,000 Igpd lagoon

- 1-1/2 acres @ $5,000 per =	$ 7,500
- 3 HP mech. aerator (s &i)=	2,500
- Miscellaneous =	2,000
Total	$12,000

c) Extended-aeration Lagoons

- This involves aeration (24 hrs., 15 lb BOD/1000 cf), final settling (4 hrs.), sludge recycle.
- Mech. aerators plus modified carriage collector for return sludge ("Greey/Lightnin"), or continuous air guns plus air guns for return sludge ("Polcon").
- Generally suited to high strength wastes in relatively large quantities.

d) Special Lagoon Configurations

-These are numerous and varied.

-Of particular interest is an "aerated lagoon plus filter" ("Neptune Microfloc") where biological treatment is used as a roughing step, followed by coagulation-sedimentation-filtration as a polishing step. This has found application for capacities of 80,000 to 225,000 Igpd, and is particularly suited for phosphorus removal. Representative cost for 225,000 Igpd project at Tualitan, Oregon was $280,000 in 1970.

8.2.2 Mechanical Alternatives

a) Activated-sludge Package Plants

i) Diffused-air Type

- Process generally used:
  . complete mix
  . contact stabilization
  . extended-aeration
- Available as completely factory-built (including steel tank) in unit capacities from 20,000 to 60,000 Igpd. Higher capacities require concrete tanks.
- The overall facility would include package plant, small control building, chlorination facilities, and outfall sewer.

- Repr. capital cost for $25,000 Igpd facility
  . Supply package plant - $25,000 ("GP" Completaire)
  . Installation plus small building - 20,000
  . Outfall and Miscellaneous - 15,000
  Total $60,000

ii) Mechanical-aerator Type

- This recent development by "Greey/Lightnin" has a long common wall between aeration and final settling tanks.
- The final tank has a special carriage collector to move solids to a baffle-slot for recycle by the strong circulation pattern of mech. aerators.
- Factory-built plant capacity range is generally as noted in i). Higher capacities require concrete tanks.
- Features claimed are higher mixed liquor solids for process stability, higher oxygen transfer efficiency for low power cost, and mechanical simplicity for better reliability and lesser supervision.
- Repr. capital cost for 25,000 Igpd facility is generally as above.

iii) Air-gun Type

- Generally as above, except continuous air guns ("Polcon") or intermittent air guns ("Carter") provide the means of aeration.

iv) Jet-Aeration Type: submersible pumps plus ejectors and low-pressure blowers (Pemberthy).

v) Liquid Oxygen Type: unit plant sizes of 0.5 to 6.0 MIGD, $150,000 for supply only of 1 MIGD plant, including oxygen generation (Union Carbide).

b) Trickling-Filters

- A treatment facility generally comprises a primary settling tank, trickling filter tank (covered) constructed of vertical corrugated steel culvert pipe with "ACM" sweep arm (20' dia.), and final settling tank.
- This class of facility has been widely used in the Maritimes - particularly New Brunswick.
- It is claimed that the trickling filter is easier to keep operational than standard diffused-air package plants. Also, it is more economical.
- Problems have been experienced with inadequate ventilation. Also, lack of recycle pumps makes treatment efficiency susceptible to shock loads.
- Repr. capital cost for a nominal facility having capacity up to 50,000 Igpd (or 250 houses) was $20,000 in New Brunswick for 1970. For a complete facility, costs could range up to $70,000.

c) Rotating-Biological Contactors

- A treatment facility generally comprises a primary settling tank, and rotating-biological-contactor module having integral final settling tank.
- Modules are available in 25,000 and 50,000 Igpd unit sizes.
- Available as Biodisc, "Autotrol" Biosurf, and "Euro-Matic" Bio-Drum.
- Should be housed for protection against the elements.
- Features claimed are low "O & M" cost and insensitivity to overloading, together with innovative mechanisms for even sewage loading and effective sludge withdrawal.
- Repr. captial cost for 25,000 Igpd facility is $70,000 (s & i).

d) Physical-Chemical Plants

i) - "Neptune Microfloc" Recla-Mate physical-chemical treatment plant is available for low capacity applications in unit capacities from 10,000 to 60,000 Igpd.
- Packaged plant comprises a rapid mix tank, flocculation tank, settling tank, first and second stage tube settlers, together with integral backwash supply system and waste water storage.
- Should be housed.
- Features claimed are efficient operation in spite of intermittent flow pattern and/or organic loading, and general suitability for phosphorus removal.
- A small unit is being used at Yellowknife, N.W.T. on a Department of the Environment demonstration project.
- Repr. capital cost for a 25,000 Igpd installation is $70,000.

ii) - "AWT Systems Inc." plant for a subdivision of 145 homes in Lake Success, N.Y.; 40,000 Igpd capacity.
- Facility comprises a wedgewire screen, surge storage tank, rapid mix tank, clarifier, special filter, carbon adsorber, chemical feeders (coagulant, acid/alkaline control additive, polymeric flocculant, magnetic additive, carbon) together with fluid-bed incinerator for solids disposal.

- Housed in a residental type building.
- Capital cost was $250,000 in 1972.

e) Biological plus Physical-Chemical Plants

- "Environment One" Chem-Bio Treatment Plant for small subdivisions and the like; up to 80,000 Igpd capacity.
- This is a modified batch process comprising aerated holding tank, main reactor tank (biological stabilization, chemical flocculation, settling), and aerobic sludge digestion.
- Should be housed.
- Features claimed are operability over a wide range of conditions, suited to a slow build-up of connected load (community growth).

f) Physical-Chemical Plants for Vacuum Sewerage Systems

i) Black-Water Process

- Suited to small communities (100 to 5,000 pop.).
- Small quantity to treat (say, 2 Igpd per person, i.e. much reduced capacity - say, 90% relative to conventional system).
- Plant comprises a collecting tank, waste water transfer pump reactor tank where waste water is circulated for intensive mixing with lime, $Ca(OH)_2$ feed system, sludge draw-off system, sludge holding tank, and ammonia expulsion tank.
- BOD reduction of 70%; complete removal of all pathogenic bacteria and viruses is claimed due to high pH.

- Also, this process claims good removal of phosphorus (99%) and nitrogen (75%).
- Equipment is often installed in a central collection station.
- Repr. capital cost:
  - 2,000 Igpd (1,000 people)
  - Supply and install - $12,000 (excluding building).

ii) Black and Grey Water Process

- Black water and grey water received in two pipes.
- Reduced capacity - say, 50% relative to a conventional system.
- Facility comprises a small treatment plant as noted above for raw black water, plus a larger plant for raw grey water and treated black water.
- The larger plant includes a mixing chamber, primary and secondary settling chambers, aeration chamber, and pH adjustment tank.
- The process precipitates and settles phosphorus, settles solids, and provides trim-up aeration prior to effluent disposal.

8.3 Discussion on Non-mechanical Alternatives

8.3.1 Lagoons

Lagoons, either standard rate or aerated type, could be considered for this installation. All types of lagoons offer the advantages of simplicity of operation and maintenance, and the ability to handle large variations in flow.

The disadvantages include:

1) Large basin requirements which are undesirable in rocky terrain,
2) Treatment efficiencies of less than secondary quality, especially under winter operating conditions,
3) Odour problems, particularly during the spring breakup period.

The disadvantages of lagoons outweight the advantages for this application and, accordingly, lagoons are not recommended.

The possibility of utilizing an existing pond for a sewage lagoon was evaluated at a site visit in Rose Blanche. Although several ponds within the vicinity of Rose Blanche could serve for this purpose, it is not recommended that a natural pond be utilized for sewage disposal.

8.4 Discussions on Mechanical Alternatives

8.4.1 Activated Sludge Plant

Due to the relatively low flow involved, a standard factory-built package activated sludge plant of the diffused air type would be suitable for this application. The process variations available as package plants are extended aeration, contact stabilization, and complete mixing. The complete mix activated sludge alternative has the least capital cost.

The activated sludge process provides secondary treatment in the order of 90 to 95% removal of BOD and suspended solids. However, the activated sludge process tends to be more complex and requires closer operator supervision than the other processes considered hereafter, and has higher operating costs due to the aeration requirements.

An alternative worthy of consideration if a mechanical aerator package plant of the complete mix or extended aeration type such as "Greey-Lightnin" manufacture. This is available as a completely shop-fabricated package including:

. Aeration tank, plus mechanical aerators.
. Final settling tank, plus special scraper mechanism.
. Chlorine retention tank, plus chlorinator.
. Sludge holding tank.

Benefits

- Operation of unit is less sensitive to cold weather. Only requirement is plywood covers over the final tank. Central control building would be small.
- Bascially simple; high reliability; requires minimum supervision.
- Significantly lower electrical energy consumption than a diffused air package plant.
- Developed and built in Canada.
- Better for shock loading due to higher mixed liquor solids (6000 to 10,000 mg/l).
- Aerobic digestion may be eliminated.

8.4.2 Rotating Biclogical Contactor

The rotating biological contactor process has been recently introduced in North America on a commercial basis. However, it has been used for a number of years in Europe. It operates on a principle similar to the trickling filter, that is, maintaining a biological slime growth on a fixed media. The processes differ in that, with the bio-disc process, the biological growth is alternately exposed to the sewage and atmosphere as the discs rotate. Organic material is removed as the discs rotate through the sewage flow during part of the rotating cycle while oxygen requirements for oxidation of the organic material are transferred in the remaining part of the rotating cycle.

For small applications, bio-disc modules are available in 25,000 and 50,000 Igpd unit sizes. The units normally follow a small primary settling tank which acts in a similar manner to that of a septic tank. The bio-disc process is a less complex system to operate and has less mechanical parts than with the activated sludge or trickling filter processes. The power requirement is relatively low since no artificial aeration is required as with the activated sludge process.

The treatment efficiency is comparable to that of activated sludge. Due to the nature of the operation and to protect the equipment during cold weather, the bio-disc units are usually enclosed in a heated insulated building. Cold weather protection also ensures a continued high treatment efficiency and prevents freezing of the biological slime on the discs.

8.4.3 Trickling Filter Plant

There are several trickling filter processes available: low rate or high rate, single-stage or two-stage, and several recirculation schemes. The treatment efficiencies of these alternatives vary from 60 to 70% BOD removal to full secondary treatment. Only those alternatives involving two-stage filtration or recirculation schemes are capable of attaining secondary treatment levels similar to that of the activated sludge process.

The recirculation schemes involve repumping a portion of the effluent back through the filter, thereby increasing potential operating problems. In addition, primary sedimentation is required to protect against plugging of distribution arms and the filter media with stringy material, large solids and grease. The treatment efficiency of the trickling filter process, as for other biological processes, is temperature dependent.

8.5 Recommended Treatment Process

Based on the preceding discussion of alternatives, it is recommended that a rotating biological contactor such as "Autotrol" Biosurf be used for sewage treatment in the Rose Blanche area (i.e. Harbour le Cou and part of Rose Blanche). This process should have low operating costs, and is expected to present few operating and maintenance problems. Second choice would be a mechanical-aerator package plant ("Greey-Lightnin"). Further, to evaluate the benefits of treatment, it is recommended to monitor receiving waters for a period of three years.

9.0 Cost Estimates

9.1 Capital Cost Estimate

9.1.1 a) General

The cost estimate hereafter is at the conceptual level, as is appropriate for this stage of project definition, and relates to an Engineering News Record, 20 cities (U.S.), Construction Cost Index of 1940.

b) Ground Rules

- New service lines between mains and buildings are excluded, but connection saddles included. Majority of service lines are existing; assume any new service lines will be paid by houseowner.
- Grinder pumps, discharge branches and existing sewer drain pipe tie-in connections are included.
- Connecting pipe from existing main sewer to common sewage pumping complex in Rose Blance is included.
- Fire protection elements (mobile pumper, etc.) are not included.
- Peripheral costs such as land, roads, electrical power service are excluded.
- Provincial sales tax based on 50 per cent of estimated capital cost is included; Federal sales tax is not included.
- Costs for engineering design services and site administration of construction are included.
- Costs for legal surveys to establish road right-of-ways, property lines, etc. are not included.

9.1.2 Details of Conceptual Cost Estimate

a) Main Water Pumping Station

- 2 Pumping Units, 5 BHP each,	$ 500 ea.	$ 1,000
- 1 Water Heater Package	2,000	
1 Circ. Pump, 3 BHP	300	2,300
- 2 Chlorinators @ $400 ea.	800	
Chlorine Feed Access.	500	1,300
- Mechanical Contractor Work (piping, equipment installation, heating, etc.). - say -		3,000
- Electrical Contractor Work (wiring, controls, lighting, etc.). - say -		2,000
- Building - 12' x 15'		
- Concrete slab on grade		2,300
- Insulated enclosure (wood or prefab)		
- Say $20/sq. ft.		3,600
- Miscellaneous		4,000
- Contingencies		4,500
	Sub Total	$24,000

b) Water Transmission Line

- Shallow Bury in Granular Road Allowance	
- Frost Cover Above Pipes	
- Piping - 3" dia., 10,600' total, $1.30 ft.	$13,780
- Frost Cover - 2' wide x 1-1/2" thick 5,300' dist., 90¢ ft.	4,770
- Installation - Shallow bury in granular 5,300' @ $2.50/ft.	13,250
- Intermediate Pumping Station	
2 Circulating pumps, 2 BHP ea., small building - say -	6,500
- Miscellaneous	3,500
- Contingencies	5,500
Sub Total	$47,300

c) <u>Water Storage Reservoir Complex</u>

- Ground Reservoir:	
- Assume reinf. concrete, 20,000 I. gal. @ $0.65/gal.	$13,000
- Water Heater Package	
- Circulating Pump	2,200
- Loop Circulating Pumps	
- Two pumps @ 2 and 3 BHP respectively - say $400/ea.	800
- Mechanical Contractor Work (Piping, equipment installation, heating, etc.) - say -	2,500
- Electrical Contractor Work (Wiring, controls, lighting etc.) - say -	1,200
- Building, say 18' x 30'	
- Concrete slab on grade	
- Insulated enclosure (wood or prefab.)	
- Some common wall with reservoir	
- say $.20/sq. ft.	10,800
- Miscellaneous	3,500
- Contingencies	4,400
Sub Total	$38,400

d) Water Distribution

I) Harbour le Cou

- Assume 75% shallow Buried in Granular road allowance with frost cover protection; 25% insulated (exposed or Buried).

- Piping:		
- 3" dia. 8,700' total @ $1.30/ft.		$11,310
- 2" dia. 1,000' total @ 90 ¢/ft.		900
- Frost Cover		
- 2' wide x 1-1/2" thick, 4,100' dist., $0.90/ft.		3,690
- Insulation		
- 3" dia. x 1-1/2" thick, 1,500' dist., $2.50/ft.		3,750
- Installation		
- Shallow-bury in granular - 4,100' @ $2.50/ft.	$10,250	
- Shallow-bury in rock trench; 1,500' @ $ 5/ft.	7,500	17,750
- Road Restoration, allow		8,500
- Miscellaneous		
- Service saddles		
- Valves		
- Bleeds - say -		6,500
- Contingencies		7,000
	Sub Total	$58,500

II) Rose Blanche

- Assume 67% Shallow Buried in Granular road allowance with frost cover protection; 33% insulated (exposed or buried).

- Piping	
2" dia., 6000' total, 90¢/ft.	$ 5,400
3" dia. 16,000' total, $1.30/ft.	20,800
- Frost Cover	
2' wide x 1-1/2" thick, 14,000' dist., $0.90/ft.	12,600
- Insulation	
3" dia. (avg) x 1-1/2" thick, 8000' dist., $2.50/ft.	20,000
- Installation	
- Shallow-bury in granular 14,000 ft. @ $2.50/ft.	35,000
- Shallow-bury in rock trench 4,000 ft. @ $ 5/ft.	20,000
- Exposed piping - 4,000 ft. @ $1.20/ft.	4,800
- Road Restoration, allow	9,000
- Miscellaneous	
- Service saddles	
- Valves	
- Bleeds - say -	16,000
- Contingencies	19,400
Sub Total	$163,000

e) <u>Sewage System</u>

I) <u>Harbour le Cou</u>

- Assume 75% shallow-buried in granular road allowance with frost cover protection; 25% insulated (exposed or buried).

- Piping (Forcemains)	
3" dia., 4,400' total @ $1.30/ft.	$ 5,720
2" dia., 1,900' total @ 90¢/ft.	1,710
- Frost Cover	
- Use that of water distribution	-
- Insulation	
3" dia. x 1-1/2" thick, 1600' @ $2.50/ft.	4,000
- Installation	
- Shallow-buried	
Use same trench as water distribution	-
Additional installation 4,700' @ $1.20/ft.	5,640
- Exposed, 1,600' @ $1.80/ft.	2,880
- Grinder-Pumping Units:	
Assume 48 pumps for 63 houses (i.e. 15 double and 33 single inst.)	
- Supply $1,000 ea.	
- Installation 150	
- s & i Disch. Br. (60' @ $2.50/ft. in rock) 150	
$1,300 (x48)	62,400
- Double installation: Existing sewer tie-in work plus larger tanks, add 15 x $250.- + 15 x $200.-	6,750

- Single installation: Existing sewer tie-in, 33 x $100.-	$ 3,300
- Miscellaneous	5,600
- Contingencies	10,000
Sub Total	$108,000

Note: Cost is exclusive of trench costs as installation in water main trench is intended.

II) <u>Rose Blanche</u>

- Sewage Pumping Complex:		
- Grinder: Moyno Mutator,		
7" dia. 5 BHP	$1,500	
- Pumps: Moyno 2SWG-8,		
5 BHP	4,000	$ 5,500
- Related Equipment		1,500
- Mech. Contractor Work (piping,		
equipment installation, heating, etc.)		2,500
- Electrical Contractor work (wiring,		
controls, lighting, etc.)		1,400
- Building, say 10' x 10'		
Wet Well: 1,500 cu.ft.		
@ $3.50/cu.ft.	$5,250	
Superstructure: 100 sq.		
ft. @ $20/sq.ft.	2,000	7,250
- Piping (forcemain):		
3" dia., 3,800' @ $1.30/ft.		4,940
2" dia., 500' @ $0.90/ft.		450
1-1/2" dia., 400' @ $0.50/ft.		200
- Frost Cover: Use water main trench		-
- Additional Installation 4,200' @ $1.20/ft.		5,040
- Insulation: 3" dia. x 1-1/2"		
thick, 500' @ $2.50/ft.		1,250
- Manhole (discharge end)		1,000
- Grinder Pumping Units:		
Assume 12 pumps for 17 houses		
(i.e. 5 double and 7 single inst.)		
- Supply	$1,000 ea.	
- Installation	150	
- s & i disch. br.		
(60' @ $2.50/ft. in rock)	150	
	$1,300 x 12	15,600

- Double Installation: Existing sewer tie-in work plus larger tanks, add: 5 x $250.- + 5 x $200.	$ 2,250
- Single installation: Existing sewer tie-in - 12 x $100.-	1,200
- Miscellaneous	2,220
- Contingencies	2,000
Sub Total	$54,300

Note: Cost is exclusive of trench costs as installation in water main trench is intended.

f) <u>Sewage Treatment Plant</u>

- Bio-disc Package Plant:	
- Primary Tank	$15,000
- Bio-disc Module	30,000
- Installation of Equipment	6,800
- Chlorination Hardware	3,500
- Mech. Contractor Work	3,400
- Electrical Contractor Work	1,800
- Small Building, 18' x 30'	10,500
- Outfall, 8" dia.	4,000
- Miscellaneous	6,500
- Contingencies	5,500
Sub Total	$87,000

9.1.3 a) Summary - Estimated Capital Cost

	All Costs: Water Supply, Distribution, Sewerage and Treatment	Water Distribution Only	Sewerage Only
Main Water Pumping Stn.	$ 24,000	-	-
Water Trans-mission Line	47,300	-	-
Water Storage Reservoir Complex	38,400	$ 38,400	-
Water Distri-bution:			
- Harbour le Cou	58,500	58,500	-
- Rose Blanche	163,000	163,000	-
Sewerage System:			
- Harbour le Cou	108,000	-	$108,000
- Rose Blanche	54,300	-	54,300
Sewage Treat-ment Plant	87,000	-	-
Sub Total	$580,500	$259,900	$162,300
Prov. Sales Tax (7% on say 50% of Capital Cost)	20,300	9,100	5,700
Engineering design & site admin. ser-vices & related costs @ 15%	87,100	39,000	24,400
Total	$687,900	$308,000	$192,400

Notes:

- school in Rose Blanche assumed equivalent to 12 homes.
- unit cost per home under "all costs" provides partial sewerage only, approx. 33%.
- cost of grinder pump and discharge branch connection assigned to system, not to houseowner.
- trench costs for sewerage system are excluded, since use of water main trench is intended.

In above table, capital costs are summarized and, as shown, the total estimated cost including engineering services and site administration services of construction for the recommended system is $687,900. The cost for the water distribution system only would be $308,000; whereas that for sewerage only would be $192,400.

b) Capital Cost Summary - Separate Water and Sewerage Systems

In the following table, estimated capital costs have been separated to indicate total costs and cost per house for each service.

	Water Supply and Distribution	Sewerage and Treatment
Estimated Capital Cost	$331,200	$249,300 (1)
Prov. Sales Tax (7% on say 50% of Capital Cost)	11,600	8,700
Engineering design & site admin. services & related costs @ 15%	49,700	37,400
Total	$392,500	$295,400
No. of Homes Serviced (future)	300	102
Cost per Home	$1,308	$2,900

(1) Sewer to be installed in water main trench.

c) Comparative Costs for Servicing

In the following summary, cost estimates developed in Appendix A for a conventional water and sewerage system for Rose Blance and Harbour le Cou are compared with those developed previously for the recommended modular system.

	Modular, Shallow-Bury System (3)		Conventional System (3)	
	Capital Cost	Unit Cost/ House	Capital Cost	Unit Cost/ House
All Costs: Water Supply, Distribution, Sewerage and Treatment	$687,900	$2,293 (1)	$1,745,600	$5,818 (1)
Water Distribution Only	308,000	1,026	1,148,400	3,828
Sewerage only	192,400	1,886 (2)	258,400	2,533 (2)

Notes:

(1) - accounts for partial sewerage only, approx. 33%

(2) - based on servicing the equivalent of 102 homes.

(3) - sewer to be installed in water main trench.

Unit costs per home have been developed for the proposed and conventional system in terms of "all costs", water distribution only and sewerage only.

As is evident from the above figures, complete services under the modular shallow-burial system can be provided for $2,293 per home (based on partial sewerage of Rose Blanche). On the basis of water distribution only and sewerage only, the respective unit costs per home would be $1,026 and $1,886.

In comparison, costs for the conventional system exceed those for the modular system by a factor in the order of 2.5. Unit costs for sewerage only are relatively similar in magnitude as trench costs are excluded.

The difficulty in servicing Rose Blanche and Harbour le Cou is reflected by the high cost for a conventional water and sewerage system. In comparison, typical unit servicing costs for conventional water distribution and sewerage systems under less severe conditions were as follows:

London, Ontario - 1969
- Std. soil, deep buried
- new subdivision .... $2,400/lot.

New Brunswick - 1970
- Std. soil, deep buried
- water and sewers $2,000-$3,000/lot (roughly 50:50 split)

9.2 Operating and Maintenance Costs

a) Heating (Fuel-oil)

i) Assume - average increase in water temp. is 10° F.
- average water consumption is 60,000 Igpd.
- fuel is No. 2 fuel oil @ 168,000 BTU/I.gal. and 35¢/I. gal. (actual cost @ 30¢/I. gal - Nov/73)
- water heater efficiency is 80%
- equivalent duration is 3 months

ii) Heat requirement:

Warm-up water	250,000 BTU/hr
Compensate for heat losses	360,000 BTU/hr
Total	610,000 BTU/hr

iii) Annual fuel cost = $2,800

b) Pumping (Electricity)

i) Circulating Pumps

- Assume 12 BHP, continuous operation for 4 months, 2-1/2¢/KW hr (actual cost @ 1.2¢/KWH - Nov/73)
- Annual cost = $640

ii) Main Supply Pumps

- Assume 5 BHP; 30% usage
- Annual cost = $250

iii) Grinder Pumps

This cost to be borne by the householder:

- Assume 65 @ 1 BHP ea; 2% usage
- Annual cost = $280 or $4.30 per pump

iv) Sewage Pumping Complex (Rose Blanche)

- Assume 7-1/2 BHP draw; 33% usage
- Annual cost = $400

v) Sewage Treatment

- Assume 5 BHP draw; 100% usage
- Annual cost = $830

c) Chlorination

- Assume average dosage @ 1 mg/l and average flow @ 60,000 Igpd for water; 8 mg/l and 20,000 Igpd for sewage; cost of chlorine at 20¢/lb; 100% duration.
- Annual cost = $160

d) Operating Staff

- Part-time operation plus periodic backup
- Assume equivalent of 1 man full-time
- Annual salary cost = $8,500

e) Sludge Disposal

- Assume solids build-up in sewage treatment plant @ 14 lbs/day, or 70 gal/day of sludge @ 2% solids.
- Assume cost of sludge disposal equal to 9-1/2¢/gal.
- Annual cost = $2,400

f) Maintenance

- Assume annual maintenance cost of $6,000/yr.

g) Summary of Annual O & M Cost

	Water System	Sewerage System	Total
Fuel Oil	$ 2,800	$ -	$ 2,800
Electricity	890	1,230	2,120
Chlorine	45	115	160
Operator	4,300	4,200	8,500
Sludge Disposal	-	2,400	2,400
Maintenance	3,000	3,000	6,000
Miscellaneous	1,265	1,255	2,520
Total	$12,300	$12,200	$24,500
No. of Homes Serviced	300	102	
Cost per Home	$41	$120	

Note:

For the initial 3-year monitoring period, it will be necessary to increase the "O & M" cost to cover:

- start-up "bugs", emergency situations, special repairs, etc.
- periodic visits by our "O & M" specialists.
- periodic visits by our engineering personnel.
- overview of operations and monitoring, including analysis and assessment on a continuing basis, together with a final report.

Accordingly, it is recommended that an estimated cost of $40,000 per year, or $120,000 total, be budgeted for this initial period.

9.3 Construction Schedule

It is recommended that construction of recommended works commence on or before June 1, 1974. Completion of construction would then be scheduled for November 1, 1974 to permit start-up of operations during mild weather.

APPENDIX A

A.1 General

As an alternate for the modular, shallow-bury, water system recommended in this report, a conventional system was developed and evaluated to permit a cost comparison between the two systems. Elements of the conventional system, including estimated capital and operating costs, are presented in Section A.3 following.

A further analysis of the modular water supply and distribution system was carried out to determine the effect on cost of providing fire protection integrally within the distribution system. Details and estimates of cost for a modular system with fire protection are presented in Section A.4 following.

Each alternative mentioned above follows similar routes and offers comparable service as the recommended system.

For ease of comparison, system characteristics and estimated costs for the recommended system are summarized below in Section A.2.

A.2 Summary of Recommended System - Modular, Shallow-Bury Water System Excluding Fire Protection.

A.2.1 System Characteristics

- pipes exposed or shallow buried in granular roadbed
- shallow buried pipes protected by frost covers
- exposed pipes protected by pipe insulation
- separate loops in the water system
- recirculate heated water in loops to prevent freezing

- bleeds in dead-end lines to prevent freezing
- enclosed reservoir
- chlorination of raw water source
- pumping to reservoir at maximum day rate
- reservoir storage of 20,000 I. gal., equal to 1/3 average day
- minimum pressures on the system of 20 psi at peak hour demand.
- sewerage system includes grinder pump and discharge branch lines.
- sewerage system assumes installation in water main trench.

A.2.2 Estimated Costs

a) Capital Cost

	All Costs: Water and Sewerage	Water Distribution Only	Sewerage Only
Main Pumping Station	$ 24,000	-	-
Transmission Mains	47,300	-	-
Reservoir Complex	38,400	$ 38,400	-
Water Distribution:			
- Harbour le Cou	58,500	58,500	-
- Rose Blanche	163,000	163,000	-
Sewerage System:			
- Harbour le Cou	108,000	-	$108,000
- Rose Blanche	54,300	-	54,300
Sewage Treatment	87,000	-	-
Sub Total	$580,500	$259,900	$162,300
Prov. Sales Tax (7% on say 50% of capital cost)	20,300	9,100	5,700
Engineering design and site admin. services, and related costs @ 15%	87,100	39,000	24,400
Total	$687,900	$308,000	$192,400

b) Operating Cost

Estimated Annual Operating Costs - $24,500
(incl. fuel oil, electricity, chlorine, sludge disposal, labour, maintenance and miscellaneous).

A.3 Modular Shallow Bury System With Fire Protection

A.3.1 System Characteristics

System characteristics are similar to recommended system with the exception of the following changes or additions:-

- larger diameter pipes capable of delivering 250 Igpm fire flow plus maximum day flow in each loop at a minimum of 20 psi.
- additional reservoir capacity of 30,000 I. gal., equal to a two-hour fire flow of 250 Igpm.
- hydrants spaced at approximately 400' distance.
- sewerage aspects are as for recommended system

A.3.2 Estimated Costs

a) Capital Cost

Pumping Station	$ 25,500
Transmission Section	82,500
Reservoir Complex	64,000
Water Distribution - Harbour le Cou	98,000
- Rose Blanche	267,000
Sewerage System - Harbour le Cou	108,000
- Rose Blanche	54,300
Sewage Treatment	87,000
Sub Total	$786,300

	Sub Total	$786,300
Prov. Sales Tax (7% on say 50% of capital cost)		27,500
Engineering design and site admin. services, and related costs @ 15%		118,000
	Total	$931,800

b) Operating Cost

Annual operating and maintenance costs have been estimated as follows:

Fuel	$ 5,000
Electricity	
- water supply pumps	250
- circulation pumps	640
- sewage pumping station	400
- sewage treatment plant	830
Chlorination	160
Sludge Disposal	2,400
Operator	8,500
Maintenance	6,500
Miscellaneous	2,520
	$27,200

A.4 Conventional Water System, Water and Sewerage, Excluding Fire Protection

A.4.1 System Characteristics

- deep buried water main in trench with minimum 5' cover to eliminate freezing.
- minimum pressure of 20 psi at all locations during the peak hour demand.
- reservoir storage of 20,000 I. gal., equal to 1/3 average day flow

- uncovered reservoir
- pump to reservoir at maximum day rate
- chlorinate raw water supply
- gravity sewers with average pipe cover of 8' assumed to be located in same trench as water main.
- sewer house connections are excluded.

A.4.2 Estimated Costs

a) Capital Cost

	All Costs: Water and Sewerage	Water Distribution Only	Sewerage Only
Main Pumping Station	$ 21,000	-	-
Transmission Main	178,000	-	-
Reservoir Complex	22,000	$ 22,000	-
Water Distribution:			
- Harbour le Cou	230,000	230,000	-
- Rose Blanche	717,000	717,000	-
Sewerage System:			
- Harbour le Cou	122,000	-	$122,000
- Rose Blanche	96,000	-	96,000
Sewage Treatment	87,000	-	-
Sub Total	$1,473,000	$969,000	$218,000
Prov. Sales Tax (7% on say 50% of capital cost)	51,600	34,000	7,700
Engineering design and site admin. services, and related costs @ 15%	221,000	145,400	32,700
Total	$1,745,600	$1,148,400	$258,400

Notes

- trench cost for installation of water main assumed as $30/ft. complete.
- gravity sewer assumed to be installed in same trench as water main - additional cost assumed as $12/ft.

b) Operating Cost

The estimated annual operating and maintenance cost is:

Electricity	
- water supply pumps	$ 370
- sewage pumps (22-1/2 BHP draw; 33% usage)	1,200
- sewage treatment plant	830
Chlorination	160
Sludge Disposal	2,400
Operator	8,500
Maintenance	11,000
Miscellaneous	4,960
	$29,400

A.5 Conventional Water System, Water and Sewerage, Including Fire Protection

A.5.1 System Characteristics

- similar to conventional system without fire protection but including following changes or additions:
  - . large dia. pipe capable of delivering 250 Igpm fire flow plus max. day flow in each loop at a min. of 20 psi.
  - . additional reservoir capacity of 30,000 I. gal. (equal to 2-hour duration at 250 Igpm).
  - . hydrants spaced at a 400' distance

A.5.2 Estimated Costs

a) Capital Cost

	All Costs: Water and Sewage	Water Distribution Only	Sewerage Only
Main Pumping Station	$ 22,500	$ -	$ -
Transmission Main	207,600	-	-
Reservoir Complex	39,000	39,000	-
Water Distribution:			
- Harbour le Cou	274,000	274,000	
- Rose Blanche	855,000	855,000	
Sewerage System:			
- Harbour le Cou	$ 122,000	-	$122,000
- Rose Blanche	96,000	-	96,000
Sewage Treatment	87,000	-	-
Sub Total	$1,703,100	$1,168,000	$218,000
Prov. Sales Tax (7% of say 50% of cap. cost)	59,600	40,900	7,700
Engineering design & site admin. & field services & related costs @ 15%	255,500	175,200	32,700
Total	$2,018,200	$1,384,100	$258,400

Notes:

- water main trench cost assumed as $32/ft. complete
- gravity sewer is same but deeper trench as water main - additional cost assumed as $12/ft.

b) Operating Cost

Apart from additional maintenance cost for about 60 fire hydrants, annual O & M costs will be similar to those for conventional system without fire protection (Sect. A.4.2 (b)).

On this basis the total annual cost would be approx. $30,000.

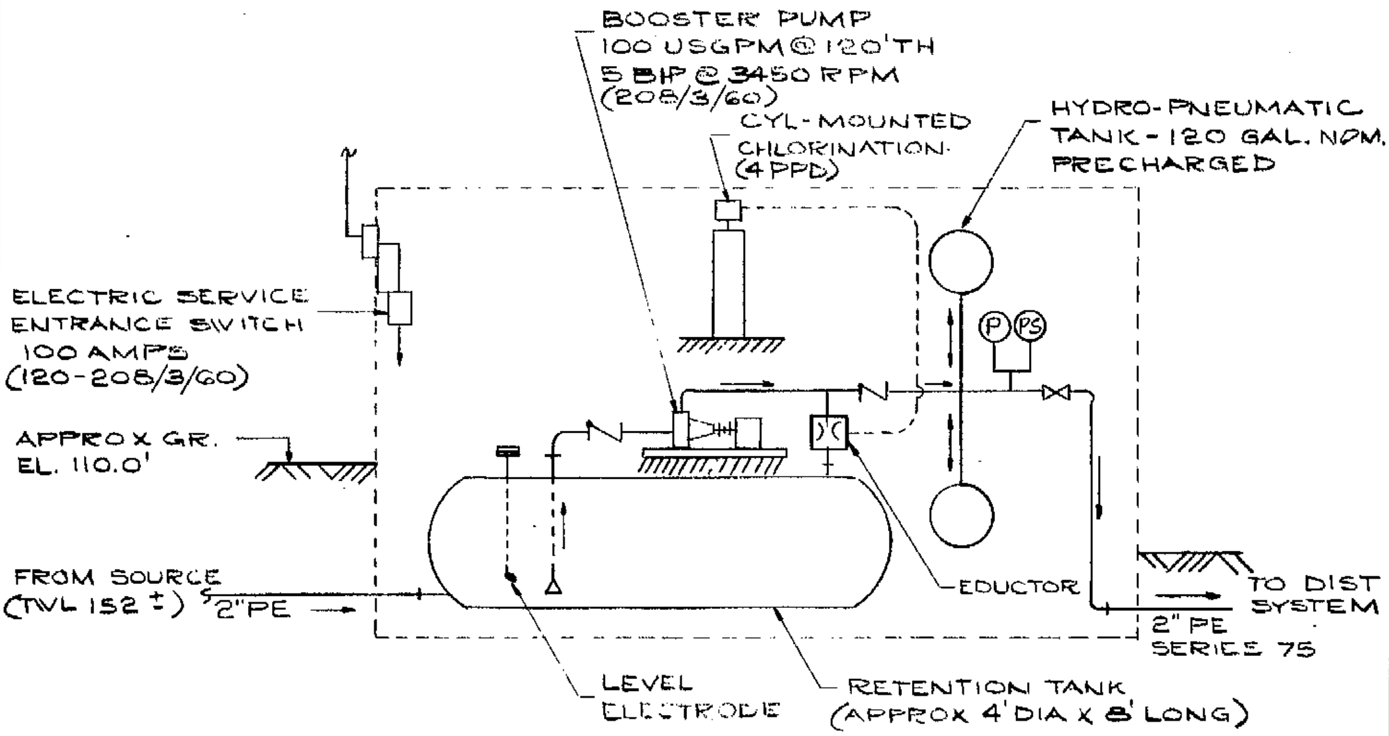
A.6 Summary

As shown by the foregoing, the extra cost to increase the size of the modular water system to handle fire flow is $243,900 (i.e. $931,800 versus $687,900) in capital costs and $2,700 in annual operating cost.

Excluding fire flow, the conventional water system would cost an estimated additional $1,057,700 (i.e. $1,745,600 versus $687,900), while the annual operating costs would increase by $4,900 to $29,400.

Unit servicing costs per house are noted in Section 8.1.3 b) in body of report under "Comparative Costs for Servicing".

Cost estimates for conventional systems with and without fire protection indicate that the increased cost for a system with fire protection is in the order of $273,000.



SCHEMATIC OF EXIST PUMPING
AND CHLORINATION STATION
IN ROSE BLANCHE

FIG. NO. 1

SCHEMATIC OF PRESSURE SEWERAGE SYSTEM

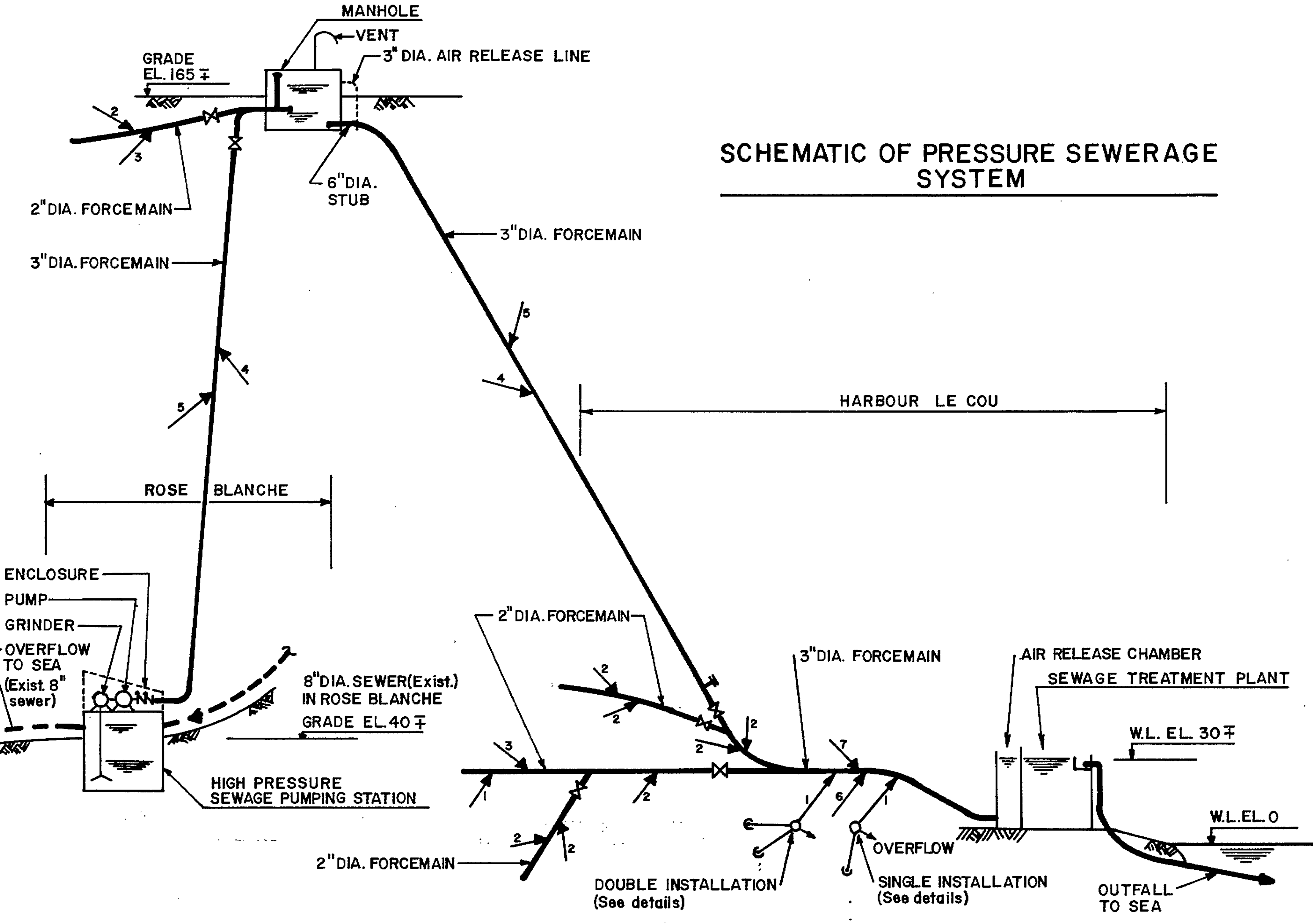
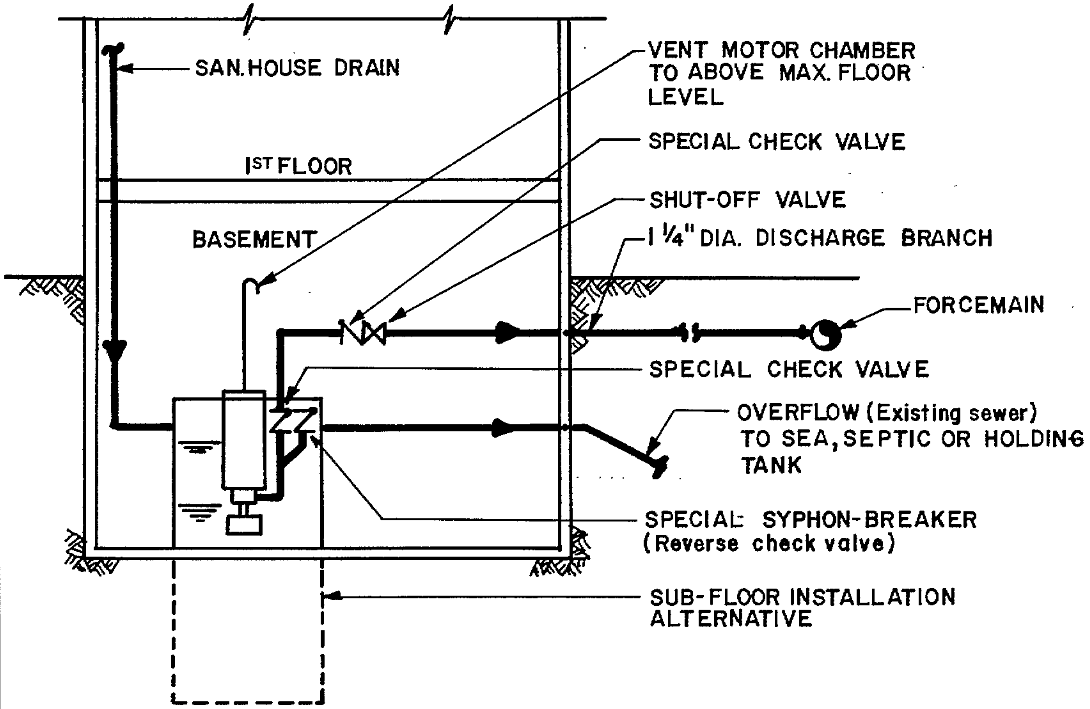
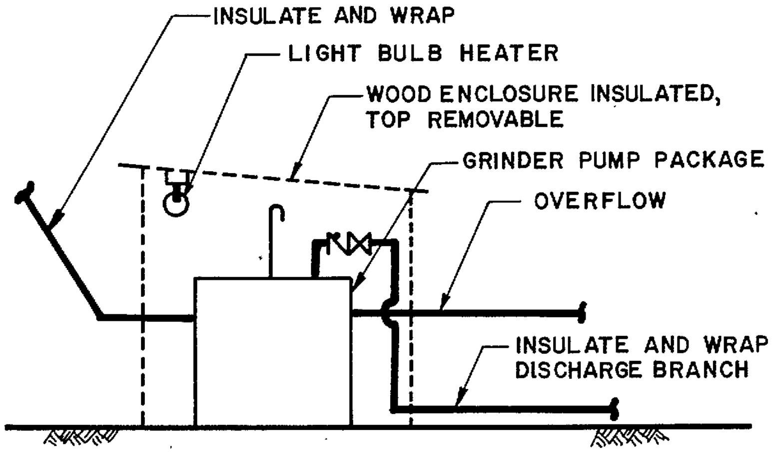


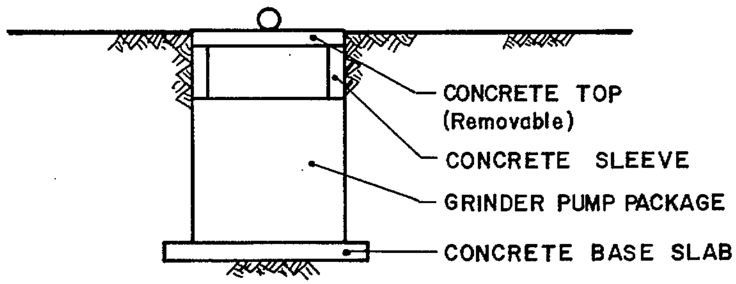
Fig. No. 3



INTERIOR INSTALLATION



EXTERIOR INSTALLATION ABOVE GRADE



EXTERIOR INSTALLATION BELOW GRADE

GRINDER PUMP INSTALLATION DETAILS

Fig. No. 4

NO.	REVISIONS	DATE	INTLS

GOVERNMENT OF CANADA
THE DEPARTMENT OF REGIONAL ECONOMIC EXPANSION

ROSE BLANCHE, NEWFOUNDLAND
MODULAR WATER AND SEWERAGE SYSTEMS

SCHEMATIC OF PROPOSED SYSTEMS

ENVIROCLEAN LIMITED
TORONTO

DATE: JAN. 1974
SCALE: NOT TO SCALE
DRAWN BY
CHECKED BY

FIG. No. 2

No.	REVISIONS	DATE	INTLS

GOVERNMENT OF CANADA
THE DEPARTMENT OF REGIONAL
ECONOMIC EXPANSION

ROSE BLANCHE, NEWFOUNDLAND
MODULAR WATER AND
SEWERAGE SYSTEMS

LAYOUT OF PROPOSED SYSTEMS

ENVIROCLEAN LIMITED
TORONTO

DATE JAN. 1974
SCALE 1" = 300'
DRAWN BY
CHECKED BY

FIG. No. 5