OPERATION AND MAINTENANCE MANUAL

FOR

WATER AND SEWER SYSTEM

1978

UTILIDOR SYSTEM

HAMLET OF RESOLUTE BAY

BAFFIN REGION

OPERATION & MAINTENANCE MANUAL

VOLUME 3

FOR

WATER & SEWER SERVICING SYSTEM

AT

RESOLUTE BAY - N.W.T.

Year of Completion - 1978

Original Scope - Intake-Pumphouse-Supply Line-Water Treatment Plant-Piped Water & Sewer Servicing and Sewage Treatment & Disposal

This manual has been updated to include:

Date	Description of Change

PROJECT MANAGER: Government of the Northwest Territories
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ELECTRICAL SUB-CONTRACTOR:

Remco Electric
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EXCAVATION SUB-CONTRACTOR:

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ELECTRICAL & MECHANICAL SUB-CONTRACTOR

Black & McDonald Ltd.
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CONTRACTOR FOR SEWER OUTFALL LINE:

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CHAPTER 3 - DESIGN DATA

1. BACKGROUND DATA

Resolute's physical development consisted of three separate areas of activity; the settlement, the airport and the "South Camp" industrial area. Each of these contained a residential sector. The settlement, the largest residential area, was located about 8 km from the airport under the approach zone of the main airstrip. In the early 1970's, it was decided to relocate the settlement to a new site further from the airstrip approach and to an area less exposed to winds and snow drifting. The residential facilities at the airport and "South Camp" were also to be moved and combined into the new townsite which would have facilites and services provided to consolidate all residential activities in the new townsite. A number of studies on alternate locations were carried out and the present site was chosen for development. Construction of site servicing for the new townsite commenced in 1974 and was essentially completed in 1978. Residents moved from the old settlement to the new site in the summer of 1975. The population of the new townsite as of November 1978 was approximately 160.

These manuals pertain to the water and sewer system provided for the new townsite. This volume pertains to the piped Water Distribution and Sewage Collection and Disposal System.

2. SITE CONDITIONS

The new townsite is located on the south slope of Signal Hill which rises to an elevation of 195 m north of the head of the bay. The land surface slopes gradually from the shore, generally in a series of stepped gravel ridges which appear to be raised beach lines.

The slope is steeper in the vicinity of the townsite which is developed within the elevation range of 10 m to 40 m. Char Lake, the water supply source for the new townsite is located approximately 2 km to the north west of the new townsite below the west slope of Signal Hill, at an elevation of 33 m.

Soil test results in the area of the new townsite indicated that the shale and limestone bedrock is generally 1.5 m to 9.5 m below the surface. The aggregate materials above the bedrock consist of frost shattered limestone and shale bedrock material of gravel size with some cobbles up to 20 m and fines which are mainly non-plastic. Slabs of bedrock material about 0.3 m thick exist immediately above the bedrock in much of the area.

The depth of the permafrost active layer varies between 0.5 m and 1 m. Permafrost ice varied from ice coatings and crystals to ice with soil inclusions, with the majority being in the form of coatings and crystals. Due to the variation in ice contents and subsequent uneven settlements if thawing occurs, it is necessary to keep the ground in a frozen state where it is used to support development. The design of the water and sewer facilities incorporates the use of rigid foam insulation under heated structures, on buried water and sewer pipes and on access vaults, for this purpose, as well as for energy cost considerations.

3. GENERAL CLIMATIC DESIGN PARAMETERS

.1 Record Low Temperature (Ref. A) - 62°F (-52.2°C)

.2 Record High Temperature (Ref. A) 65°F (18.3°C)

.3 Daily Mean Annual Air Temperature (Ref. A) 2.8°F (-16.2°C)

.4 Mean Annual Ground Temperature (Ref. B) 9°F (-12.7°C)

.5 Building design minimum outdoor air temperature condition (1% basis - Ref. C) at 15 mph design wind velocity[(1)] - 49°F (-45°C)

.6 Buried pipe design minimum ground temperature at minimum 2 ft. pipe depth $-10^{\circ}F$ ($-23.3^{\circ}C$)(2)

.7 Building heating degree days below $65^{\circ}F$ ($18.3^{\circ}C$) (Ref. C) 22,673 $^{\circ}F$ days ($12600^{\circ}C$ days)

.8 Buried pipe heating degree days below $42^{\circ}F$ $12,000^{\circ}F$ days ($6670^{\circ}C$ days)(2)

.9 Mean annual total precipitation (Ref. A) 5.36 in. (13.6 cm)

(1) Assumed (2) Estimated

4. ENERGY COST DATA USED

.1	Power Cost (1974)	12¢/KWH
.2	Fuel Oil Cost (1974)	$1.00/gal. (22¢/1)
.3	Fuel Oil Heating Value	160,000 Btu/gal. (37,180 kj/1)

5. ALTERNATIVES CONSIDERED

.1 Single Main Versus Daul Main Water Circulation System

See this section of the manual on the Water Treatment and Storage Facility (Volume 2).

.2 Alternative Water & Sewer Piping Systems

In addition to Item .1 (above), the "Report on Alternative Water & Sewer Piping Systems" (UMA, February 1976) investigated the following:

a) Freeze Protection of Services

Pit-orifice versus circulation pumps versus electrical heat tracing; of service lines.

b) Piping Material and Insulation

Direct insulated polyethylene pipe mains versus insulated corrugated metal utilidor enclosure with PVC piping mains.

c) Arrangement for Insulation of Appurtenances

Drained insulated access vault system versus direct insulated and buried appurtenances (for direct insulated polyethylene pipe system).

On the basis of the findings of the report and subsequent tenders received for service line alternatives, the alternatives selected were as follows:

a) Dual pit-orifice copper water services in common insulation service bundle with polyethylene sewer service line, with no heat tracing, but provision for electrical thawing of copper lines using welding machine or transformer. Water service line circulators to be installed in buildings with service line length greater than 70 ft. (21 m) and on dead-end water mains.

b) Direct insulated polyethylene pipe mains, with heat tracing cable in continuous conduit system.

c) Insulated and electrically heated access vaults except with use of sump pumps rather than a gravity drain system for removal of ground water infiltration from the vaults. The vaults contain all appurtenances and accessories, including electrical breaker panels and thermostats for electrical tracing of mains.

.3 Sewage Treatment Alternatives

Sewage Treatment alternatives considered for the Resolute Bay new townsite in the "Report on Study of Pollution Control Systems" (UMA, September 1974) were:

a) Package Contact Stabilization Plant

b) Rotating Biological Contactor Plant

On the basis of the findings of the report, the Rotating Biological Contactor process was selected and the design of the plant completed. The building foundation and shell was constructed in 1976, however, it was subsequently decided that its completion would be postponed indefinitely, and that, instead, comminution and direct disposal of sewage to the bay would be provided.

6. FACILITY DESIGN PARAMETERS USED

.1 First stage design population level - 900(1)

.2 Ultimate design population level - 1,500(1)

.3 Average water demand 70 gal. (320 l) per capita per day(1)

.4 Maximum day water demand 140 gal. (640 l) per capita per day(1)

.5 Peak hourly water consumption demand: 280 gal. (1280 l) per capita per day (or 292 gal. (1325 l) per minute at 1,500 population level)(1)

.6 Water main sizing (based on reservoir elevation for gravity water pressure) to provide a combined fire and peak consumption flow, for the 1,500 population level, of 1,200 gallons (5400 l) per minute with a minimum residual pressure of 20 psi (140 KPa) in any part of the distribution system(1). (Resultant static pressure in the water mains within the townsite varies between 58 and 97 psi (400 and 670 KPa) depending on elevation within the townsite.)

.7 Continuous circulation flow velcoity in single 8" water main loop of 3.2 feet per second (0.98 m/s) to provide for adequate circulation rate in dual pit-orifice water services(2)

.8 Gravity sewage collection system sloped for minimum velocity of 2 fps (0.61 m/s). (This results in a design minimum grade of 0.6% on 6" (150 mm) size and 0.4% on 8" (200 mm) size.)

.9 Average, maximum-day and peak hourly sewage flows: same as average, maximum-day and peak hourly water demand (See .3, .4 and .5 above)(1)

.10 Comminution, recording of sewage flow and direct disposal of sewage (above high water line) to the bay

.11 Buried water and sewer line minimum fluid temperature 42^{o}F (5.6^{o}C)

.12 Access vault interior space minimum design temperature 50^{o}F (10^{o}C)

.13 Provision for cleanout of sewer mains and valving for isolation of portions of the water main distribution system for repairs, etc.

.14 Provision for accessibility to all appurtenances, accessories and electrical devises, for servicing, etc.

(1) Assumed (2) Estimated

7. SPECIAL BUILT-IN FEATURES OF DESIGN

.1 Water and Sewer Main Heat Tracing Cable System

Intended as a back-up system for the Water Treatment Plant boiler heating/circulation system which should provide essentially all of the heating requirement for the water mains and service lines. The heating cables are thermostatically controlled for automatic freeze protection during early stage low sewage flow conditions, or during Water Treatment Plant boiler system failure. Can also be used for emergency thawing of frozen mains.

.2 Extractability and Accessibility to Termination of Heat Tracing Cable

Both ends of heat tracing cables are extended to junction boxes in the access vaults (or to above ground junction boxes on posts in the case of the sewer outfall line) through continuous conduit runs, in order to be able to replace a faulty heat tracing cable by pulling through the conduit run. The non-powered end of the heat tracing cable is also connected to terminal blocks within the junction boxes in order to be able to easily test for continuity of the heat tracing bus wires, or for temporarily powering the cable from both ends in the case of bus wire non-continuity.

.3 Water & Sewer Main Future Extension

Capped stubs for sewer mains, valved and blind flanged stubs for water mains, and vault knock-out panels have been provided in specific vaults, for future extensions. See Drawing D-101 for Stage 1A, Drawing 47-R-102 for Stage 1B and "Vault Detail" Drawings for provisions made.

.4 Services to Vacant Lots

Capped service line stubs with marker posts have been provided to vacant lots for future connection. See Drawings D-102 and D-103 (Record Drawing issue) for Stage 1A, Drawings 47-R-103 to 47-R-106 (inclusive) for Stage 1B and "Typical Service Connection" drawing details.

.5 Service Valve Locations

For purposes of locating service valves, service valve locations are shown with "tie-in" dimensions to access vaults in the case of Stage 1A and with "ties" to buildings in the case of Stage 1B. See the drawings (record drawing issue) referred to in .4 (above).

.6 Thawing of Service Lines

Thaw wire jumpers have been provided to connect the dual water service lines at the water main. Di-electric couplings are provided within the buildings serviced, for connection of a welding machine or transformer across the di-electric coupling, for thawing purposes.

.7 Water Main Valving

Valves have been provided on the water main to allow for isolating certain sections of the water main loop, while at the same time maintaining circulation flow in the remainder of the system by opening the applicable normal-closed "short-circuiting" valve. Refer to Drawing D-200 (Stage 1A) and Drawing 32-R-201 (Stage 1B).

Under normal operating conditions, all valves must be in "normal" position shown on Drawing 32-R-201 to maintain the required flow velocity in all mains.

.8 Dead-end Water Mains

An internal recirculation line, to provide induced circulation flow, has been provided on the dead-end water mains to AV 22(H) and AV 25 in Stage 1B. Refer to Drawings 32-R-201 and 32-R-205.

.9 Bleeds to Dead-end Sewer Lines

Water bleed lines with globe valves for throttling, have been provided in access vaults at sewer dead-ends, for purposes of freeze protection of the low-flow sewer lines without the use of electrical heat tracing cable. Bleeds are installed in access vault Nos. AV-2, AV-4, AV-27 and

AV-28 in Stage 1A (see typical detail on Drawing D-204), and in access vault Nos. AV-17, AV-19, AV-22 and AV-25 in Stage 1B. See typical detail on Drawing No. 32-R-205.

.10 Low-point Drains on Water Mains

2" size low-point drains (with normally closed 2" valve) have been installed in AV-11 and AV-18 for emergency draining of the water distribution system should this be required. A hose would be connected to the drain valve for draining the bulk of the water, after which time the remainder would be pumped. Hydrants would be opened to allow venting.

.11 Minimum Flow By-pass Lines

A 3/4" Minimum Flow By-pass has been provided on the water main in AV-12, and provisions have been made for addition of same in future in AV-14 and AV-16. These are intended to allow for a minimum circulation flow to off-set heat loss in those portions of the water main which are not part of the main circulation loop, (i.e., AV-12 to AV-13). Refer to Stage 1B, Drawings 32-R-201 and 32-R-205.

.12 Thermister Temperature Sensing Station

This has been installed near AV-21 for temperature observation of the water and sewer lines and the surrounding soil temperature regime, and is intended for future design purposes. Refer to Stage 1B, Drawing 26-R-302 and supplier's information.

.13 Comminutor Bypass Line

The 8" bypass line has been provided to allow for automatic overflow bypass in the case of flow blockage in the comminutor or parshall flume. A manually controlled 8" normally closed knife gate valve is provided at the upstream end to allow flow bypass for servicing of the comminutor or parshall flume. Refer to Stage 1A, Drawing D-212.

.14 Provisions at Water Treatment Plant

Refer to this section in the manual on the Water and Treatment and Storage Facility for features provided there which serve for the operation of the Water Distribution System.

8. ACCEPTED RISKS

.1 Time Required to Thaw Frozen Mains

Design heating cable capacity must be limited when used in conjunction with polyethylene pipe in order to avoid damage by over heating. Thus fairly long thaw periods, in the order of one to three weeks, would be required to thaw a frozen main using the 4 watt per foot heating cable for thaw purposes.

.2 Concurrent Failures

There is generally at least one means of back-up freeze protection built into each part of the system. There is, however, a risk of freeze-ups occurring in the case of certain combinations of concurrent failures of components on sub-systems if this occurs over a long enough period of time. The procedure to follow in each case would depend on the failure combination and each combination would have to be considered separately. For example, one of the more likely to occur would be a general power failure and an emergency engine/generator failure occurring concurrently and both failures extending over a sufficient period. In this case the water distribution system would have to be drained and water would have to be delivered by tanker truck.

.3 Sewer Outfall Termination

The 8" sewer outfall line is terminated above high water line on the shore of the bay. (Refer to Drawing B-106.) At this location it could be damaged by grounded ice being pushed up the shore under certain wind and ice massing conditions in the bay. The present location is a compromise between having the discharge point as near to the low water line as possible in order to minimize the nuisance aspect at the shoreline and to minimize the likelihood of freeze-off, and at the same time maintaining a reasonable safety margin against ice damage. A solution would be to have a sub-marine outfall, but costs, at least in this initial stage, would likely have been found to be prohibitive.

REFERENCES CITED

(A) "Climate of the Canadian Arctic" prepared by Department of Transport, published by the Departmentof Eenrgy Mines and Resources, Ottawa 1970.

(B) "Permafrost in the Canadian Arctic Archipelago", R.J.E. Brown, National Research Council, Ottawa, Sept. 1972.

(C) "Climatic Information for Building Design in Canada". Supplement No. 1 to the National Building Code of Canada, Ottawa 1970.

(D) " A Hydrological Assessment of the Char Lake Drainage Basin", W.B. Kirchner, Toronto March 1974 (for Underwood McLellan (1977) Ltd., Edmonton).

RESOLUTE BAY - N.W.T.

SEWAGE COLLECTION & DISPOSAL

NOTES: 1. Item numbers 12 refer to the Schematic Diagram

2. Tag numbers 13 refer to the Valve Directory

STAGE 1A

Table of Component Functions

ITEM NO.	NAME	LOCATION	FUNCTION PERFORMED	REMARKS (TAG NO.)
1	Gate Valve	Vault #AV-2	Bleed Point/Test Connection Shut-off	4D
2	Gate Valve	Vault #AV-2	Sump Pump Hook-up Shut-off	3D
3	Gate Valve	Vault #AV-3	Bleed Point/Test Connection Shut-off	12D
4	Gate Valve	Vault #AV-3	Sump Pump Hook-up Shut-off	11D
5	Gate Valve	Vault #AV-21	Test Connection Shut-off	91D
6	Gate Valve	Vault #AV-21	Sump Pump Hook-up Shut-off	92D
7	Gate Valve	Vault #AV-21	Test Connection Shut-off	90D
8	Gate Valve	Vault #AV-30	Sump Pump Hook-up Shut-off	117D
9				
10	Gate Valve	Vault #AV-30	Test Connection Shut-off	116D
11	Gate Valve	Vault #AV-29	Test Connection Shut-off	115D

ITEM NO.	NAME	LOCATION	FUNCTION PERFORMED	REMARKS (TAG NO.)
12	Gate Valve	Vault #AV-29	Sump Pump Hook-up Shut-off	114D
13	Gate Valve	Vault #AV-6	Test Connection Shut-off	24D
14	Gate Valve	Vault #AV-6	Test Connection Shut-off	25D
15	Gate Valve	Vault #AV-6	Sump Pump/ Hook-up Shut-off	26D
16	Gate Valve	Vault #AV-4	Bleed Point/ Test Connection Shut-off	19D
17	Gate Valve	Vault #AV-4	Sump Pump Hook-up Shut-off	18D
18	Gate Valve	Vault #AV-5	Test Connection Shut-off	23D
19	Gate Valve	Vault #AV-5	Sump Pump Hook-up Shut-off	22D
20	Gate Valve	Vault #AV-7	Test Connection Shut-off	30D
21	Gate Valve	Vault #AV-7	Sump Pump Hook-up Shut-off	29D
22	Gate Valve	Vault #AV-8	Test Connection Shut-off	34D
23	Gate Valve	Vault #AV-8	Test Connection Shut-off	112D
24	Gate Valve	Vault #AV-8	Sump Pump Hook-up Shut-off	113D
25	Gate Valve	Vault #AV-28	Bleed Point/ Test Connection Shut-off	111D
26	Gate Valve	Vault #AV-28	Sump Pump Hook-up Shut-off	110D

ITEM NO.	NAME	LOCATION	FUNCTION PERFORMED	REMARKS (TAG NO.)
27	Gate Valve	Vault #AV-9	Test Connection Shut-off	38D
28	Gate Valve	Vault #AV-9	Sump Pump Hook-up Shut-off	37D
29	Gate Valve	Vault #AV-10	Test Connection Shut-off	40D
30	Gate Valve	Vault #AV-10	Sump Pump Hook-up Shut-off	39D
31	Gate Valve	Vault #AV-10	Test Connection Shut-off	41D
32	Gate Valve	Vault #AV-11	Test Connection Shut-off	43D
33	Gate Valve	Vault #AV-11	Test Connection Shut-off	44D
34	Gate Valve	Vault #AV-11	Sump Pump Hook-up Shut-off	45D
35	Gate Valve	Vault #AV-27	Bleed Point/Test Connection Shut-off	105D
36	Gate Valve	Vault #AV-27	Sump Pump Hook-up Shut-off	106D
37	Gate Valve	Vault #AV-12	Test Connection Shut-off	54D
38	Gate Valve	Vault #AV-12	Sump Pump Hook-up Shut-off	55D
39	Gate Valve	Vault #AV-12	Test Connection Shut-off	52D
40	Gate Valve	Vault #AV-32	Test Connection Shut-off	120D
41	Gate Valve	Vault #AV-32	Sump Pump Hook-up Shut-off	121D