4.3.5.2 Lagoon Systems

In the "Guidelines for the Planning and Design of Wastewater Lagoon Systems in the NWT" (MACA, 1988 - referred to as "Guidelines for Lagoon Systems"), the options suggested for lagoon systems are:

.1 Continuous Discharge (short detention and long detention)
.2 Intermittent Discharge
.3 Zero Discharge.

A continuous discharge system where effluent is permitted to drain from the lagoon continuously may not be appropriate for a trucked collection system in Resolute Bay because of the relatively small volumes of sewage which would be discharged on a daily basis (approximately 16 m^3 to 28 m^3). In the winter months the sewage may freeze within a short period of its discharge into a lagoon, creating a large frozen mass of sewage accumulating over the course of the winter. Under these circumstances a continuous discharge system is not practically possible.

A continuous discharge system is appropriate for a piped collection system in Resolute Bay because of a larger continuous discharge flow of effluent with a piped system. The larger continuous flow will discourage the accumulation of frozen sewage in the lagoon discharge and the continuous discharge will reduce the fluid retention volume required for the lagoon.

A performance study of a continuous discharge system in Iqaluit (UMA, 1995) recorded average effluent reductions of 40% for BOD_5 and 60% for suspended solids. Based upon undiluted effluent from a piped system with values of 250 mg/L for BOD_5 and suspended solids, the expected effluent quality would be 150 mg/L for BOD_5 and 100 mg/L for suspended solids.

This expected performance would not meet the effluent quality guideline of 120 mg/L for BOD_5, therefore a preliminary treatment system such as a mechanical screen may be required.

An intermittent discharge where the annual accumulation of sewage is discharged from the lagoon, generally once in the fall, is appropriate for a trucked collection system in Resolute Bay. If the discharge were scheduled for the fall of each year any frozen mass of sewage would have the opportunity to thaw and undergo some treatment within the lagoon over the limited summer months.

A zero discharge system may not be appropriate for either a trucked or piped system if evaporation is considered to be the only means of effluent "discharge". There would likely be an inadequate period of time where evaporation would reduce the annual effluent volume. However, exfiltration may be considered as a mechanism for the operation of a zero discharge system. Continuous exfiltration throughout the year would not occur in Resolute Bay. Contents of the lagoon and the berm itself will completely freeze during the winter months. Evaporation and exfiltration would therefore discontinue during the winter months.

Based upon the factors affecting the three general options for lagoon systems, we recommend a continuous discharge lagoon system with a preliminary screening system for a piped collection system and an intermittent discharge lagoon system for a trucked system.

4.3.5.3 Lagoon Operation for Intermittent Discharge (Trucked System)

There are two operating options which are feasible for an intermittent discharge lagoon system in Resolute Bay. These options are a storage lagoon or a seepage lagoon.

A storage lagoon would contain all the sewage generated for an entire year and be discharged on an annual basis. The storage should be designed to be near impermeable.

A seepage lagoon would discharge on a seasonal basis naturally because the sewage deposited into the lagoon would remain frozen for the winter months, and because of the freezeback of the dykes creating an impermeable barrier. A "seepage" storage lagoon may be feasible for Resolute Bay, however, the uncontrollable nature of the seepage may not be appropriate from an operations perspective. A seepage lagoon may also eventually operate as a storage lagoon as a result of the seepage paths being blocked with solids.

A storage lagoon may be expected to achieve reasonably high reductions of the major effluent parameters identified in the NWT Water Board Guidelines. The Guidelines for Wastewater Lagoon Systems suggest that a fall discharge of a storage lagoon may achieve BOD concentrations of 10 mg/L, SS concentrations of 25 mg/L and F.Col. concentrations of 10^2.

A storage lagoon is the recommended configuration of a lagoon system in Resolute Bay. A storage lagoon may consist of a constructed earth fill lagoon or an existing natural impoundment. The selection between these two options will depend on a specific lagoon siting study and an investigation for suitable granular materials for construction.

4.3.5.4 Disposal Options for Continuous (Piped System) and Intermittent (Trucked System) Discharges

The Guidelines for Disposal of Wastewater in Coastal Communities of the Northwest Territories (MACA, 1990) proposes six options for the disposal of wastewater. The options are:

.1 Direct Shore Discharge - effluent discharged directly onto beach through pipe
.2 Indirect Shore Discharge - effluent exfiltrates from lagoon and discharges through overland drainage (lagoon some distance from shore)
.3 Seepage Shore Discharge - effluent exfiltrates from lagoon directly to ocean (lagoon on shore)
.4 Surface Outfall - effluent discharged some distance from shore through surface pipe
.5 Submerged Outfall - effluent discharged some distance from shore through submerged pipe
.6 Batch Disposal - effluent barged some distance from shore and discharged.

The recommended discharge system for a storage lagoon (trucked system) is a direct shore discharge or a surface outfall. Either of these discharge systems should be adequate for the expected effluent quality from a storage lagoon. However, the most appropriate discharge system will depend upon the final design of the lagoon.

The recommended discharge system for a continuous discharge lagoon (piped system) is a submerged outfall. This type of discharge system is necessary for the anticipated lower quality effluent and the potential for a discharge into an embayed area. A submerged discharge will allow effluent dispersion and reduce the potential environmental impacts.

4.3.5.5 Bird Hazard

A sewage lagoon may be an attraction for birds as a source of food during the brief period when the lagoon is not frozen. The birds may in turn create a potential hazard for aircraft taking off and landing at the airport, particularly with the relatively close proximity of the airport in Resolute Bay.

If birds were to frequent a lagoon located near the community at any particular time, their expected flight lines (lagoon to community return, and lagoon to ocean return) should not cross the airport flight lines.

4.3.5.6 Lagoon Configurations

The storage lagoon to serve a trucked sewage collection system should be constructed with a volume of 7,800 m^3 (2,014 population of 251 @ 31 m^3/c/year), with an additional allowance for sludge accumulation and blowing snow. Sludge may or may not be removed on a regular basis, therefore, the lagoon should be designed to accommodate the entire 20 year sludge accumulation. Although snow fencing may be utilized to minimize snow accumulation, a volume allowance of 5% for snow accumulation would be prudent. The design volume for the lagoon is therefore 8,800 m^3 (7,800 m^3 + 550 m^3 + 450 m^3). Table 4-3 details the preliminary design criteria for a constructed storage lagoon.

The use of a natural impoundment in place of a constructed storage lagoon may eliminate the parameters of geometry, interior and exterior side slopes, exterior and interior side slopes, berm construction, erosion protection, berm width, soil density, and berm overflow depending upon the configuration of the natural impoundment.

The continuous discharge lagoon to serve a piped discharge system (assume 300 L/c/d) should be constructed with a volume of 1,000 m^3 (2014 population of 251 x 300 L/c/d x 12 day hydraulic retention time) with an additional allowance for sludge accumulation and blowing snow. The design volume for the lagoon is 1,200 m^3, including a 150 m^3 allowance for sludge accumulation and a 5% allowance for snow accumulation. Table 4-4 details the preliminary design criteria for a continuous discharge lagoon.

TABLE 4-3 PRELIMINARY DESIGN CRITERIA FOR STORAGE LAGOON (TRUCKED SYSTEM)	
Parameter	**Criterion**
Design Horizon	20 years
Storage Volume	8,800 m^3
Number of Cells	One
Liquid Depth	2.0 m
Storage Considerations	Allowance for Sludge and Snow
Geometry	2:1/Length:Width
Exterior Side Slopes	4:1
Interior Side Slopes	3:1
Berm Construction	Granular Material/Impermeable Liner
Erosion Protection	Yes
Berm Top Width	3 m
Soil Density	95% SPD
Freeboard	1 m
Berm Overflow	Yes
Lagoon Discharge	Yes (Direct Shore Discharge or Surface Outfall)
Truck Discharge	Yes

TABLE 4-4
PRELIMINARY DESIGN CRITERIA FOR CONTINUOUS DISCHARGE LAGOON

Parameter	Criterion
Design Horizon	20 years
Total Storage Volume	1,200 m^3
Number of Cells	Two (600 m^3 each)
Liquid Depth	3.0 m
Storage Considerations	Allowance for Sludge and Snow
Geometry	2:1/Length:Width
Exterior Side Slopes	4:1
Interior Side Slopes	3:1
Berm Construction	Granular Material/Impermeable Liner
Erosion Protection	Yes
Berm Top Width	3 m
Soil Density	95% SPD
Freeboard	1 m
Berm Overflow	Yes
Lagoon Discharge	Yes (Submerged Outfall)

4.3.5.7 Potential Lagoon Locations

An intermittent discharge lagoon located within a reasonably close proximity to the community would be favourable from the perspective of simple access and close proximity to the ocean for the annual discharge.

A continuous discharge lagoon within a reasonably close proximity to the community would also be favourable with respect to capital cost and operation and maintenance cost for a lift station and long force main.

A lagoon close to the community could be constructed to the west or to the southeast (see Figure 4-1). A minimum setback of 450 m would be required from the community. A lagoon to the southeast of the community may be more favourable because of predominant winds.

A natural impoundment may make use of several existing water bodies to the southwest of the community.

The lagoon location will ultimately depend upon the desires of the community and the constructability of the lagoon in any particular location.

4.3.6 Phasing Lagoon Systems

The construction of a sewage lagoon should receive highest priority for phasing in a trucked sewage disposal system. The lagoon will be required for the trucked sewage which will be much less diluted than the current sewage effluent. The lagoon may also be required for piped sewage because shutting down some sections of the pipe system would eliminate existing "bleeders", thereby possibly reducing the dilution of the sewage.

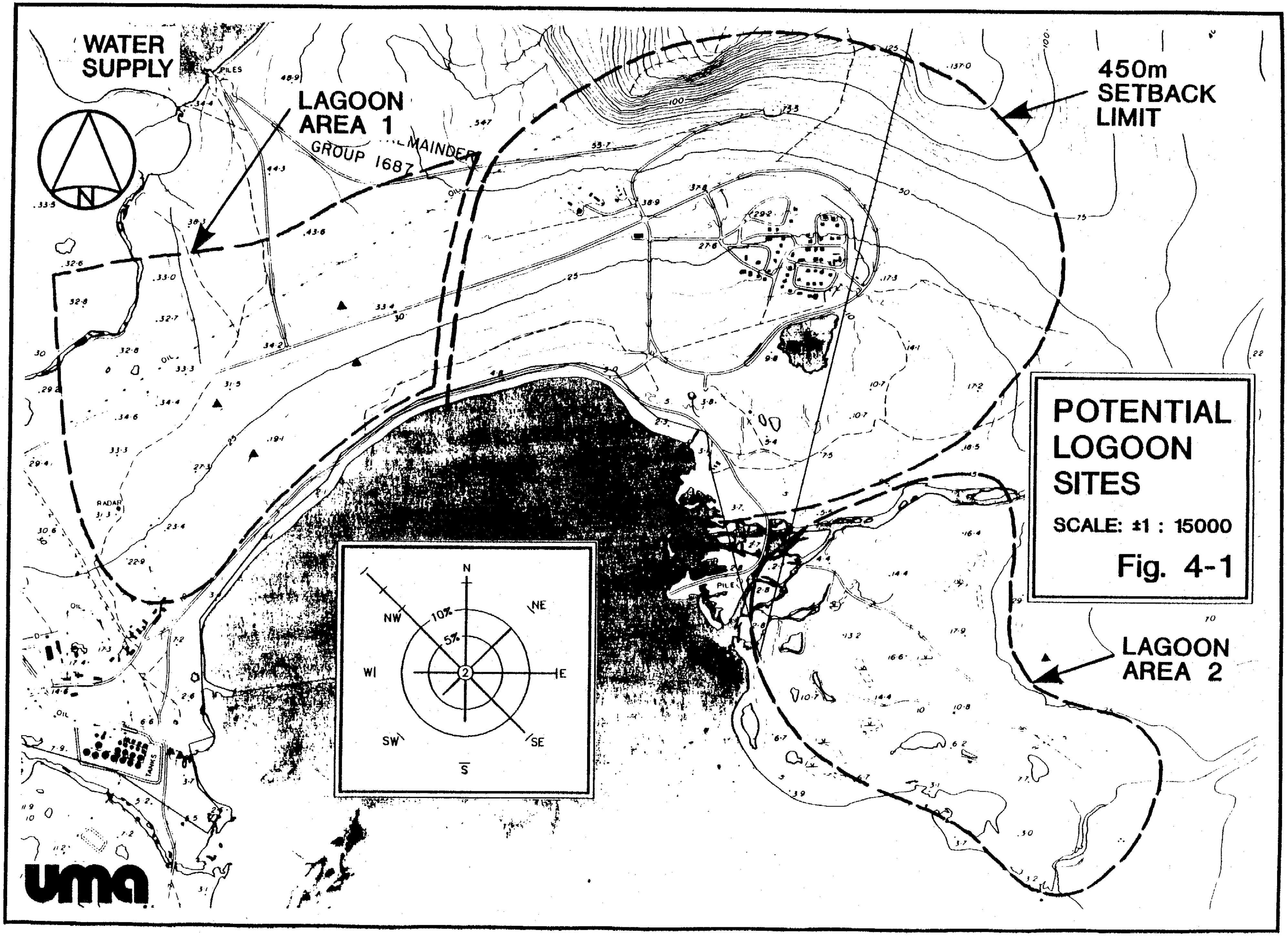
4.4 REQUIREMENTS FOR DECOMMISSIONING

4.4.1 General

In order to convert the water supply and sewage disposal systems in Resolute Bay from piped to trucked systems, some of the existing infrastructure would be decommissioned. The facilities which will require decommissioning will depend upon the facility used for a truckfill station, but could include the following:

.1 Supply Main to Signal Hill Treatment Plant
.2 Signal Hill Treatment Plant and Storage Tank
.3 Buried Water Distribution and Sewage Collection Pipes, including access vaults
.4 Sewage Comminutor Building
.5 Sewage Outfall.

Some of the equipment in the decommissioned facilities could be salvaged for reuse. Salvageable equipment and potential uses can be identified when decommissioning plans are made.


WATER SUPPLY
LAGOON AREA 1
GROUP 1687
450m SETBACK LIMIT
POTENTIAL LOGOON SITES
SCALE: ±1 : 15000
Fig. 4-1
LAGOON AREA 2
N
NE
E
SE
S
SW
W
NW
10%
5%
TANKS
RADAR
OIL
PILES

4.4.2 Regulations

Currently the NWT Health Act, Northern Inland Waters Act and the Water License for Resolute Bay require the Department of Health and the NWT Water Board to approve a decommissioning plan prior to decommissioning any of these facilities. According to the NWT Water Board (B. Collins, 1994), this plan is to contain details on what is to be done with the existing facility or system and what is proposed to replace the decommissioned facility or system.

The GNWT Department of Renewable Resources must be contacted regarding decommissioning only if there has been a spill of some type of contaminant such as fuel or sewage at the facility. The GNWT Department of Safety and Public Service must be contacted regarding disposal of any fuel oil system equipment.

Except for the submission and approval of the decommissioning plan, there currently are no specific guidelines for decommissioning water and sewer infrastructure in the NWT. However, it is our understanding that the GNWT Department of Health has started a committee to develop regulations on this issue (McKinnon, 1994).

4.4.3 Options

For facilities in Resolute Bay, there are two options for decommissioning the water and sewer infrastructure. Each facility could be either removed entirely or left in place with useful equipment removed, potentially dangerous equipment removed or secured safely, and the facility secured to prevent unwanted entry and/or damage.

The least costly option for most facilities in Resolute Bay is the second option of leaving the facility in-place. According to the NWT Water Board (B. Collins, 1994), this is an option they could consider acceptable for each facility, including buried piping, particularly if there is less environmental disturbance by leaving the facility in-place than removing it.

Where possible, in preparing decommissioning cost estimates, the decommissioned facilities are left in-place in a secured state and buried pipe abandoned in the ground. The only exception to this is the removal of the upper part of concrete access vaults, including hydrants, which would not be aesthetically pleasing to leave in-place, then filling in and over the remaining portion with granular material. Sewage lines should also be disinfected by flushing with chlorinated water and the sewage outfall line should be removed.

5.0 COST ESTIMATES

The cost estimates contained in this section are preliminary Class "D" estimates only, which are based on general concept requirements and indicate the approximate magnitude of the proposed works. All prices are in 1996 dollars and have been adjusted as required using the Northern Community Index (NCI) (MACA, 1986).

Capital cost estimates include estimates for the supply and installation of major system components and allowances for miscellaneous or incidental items. Where available, tendered prices for similar work in other NWT communities have been used in preparing the estimates.

Operation and maintenance costs, except building heating and trucked system costs, are all based on historical operating costs in Resolute Bay. Historical costs have been adjusted as required to suit system upgrades. Heating costs are estimated through theoretical heat loss calculations.

The trucked system life cycle costs are estimated following the procedure outlined in Appendix D of MACA, 1986. The calculation sheets for a trucked system in Resolute Bay are contained in Appendix I of this report.

Estimate sheets for all significant cost estimates are contained in Appendix I of this report. These estimate sheets further detail the items included with each estimate contained in this section.

5.1 EXISTING SYSTEM OPERATION AND MAINTENANCE COSTS

The costs to operate and maintain the existing water and sewer facilities at Resolute Bay have been obtained from Maintenance Work Order Summaries (DPWS, 1994) for these facilities. The work order summaries cover the period from Fiscal Year 1988/89 to Fiscal Year 1993/94 inclusive. The Maintenance Work Order Summaries are part of the Maintenance Management System (MMS) of the DPWS which was started in approximately 1988. Due to normal system start up difficulties, the first few years of data are not reliable (Burton, 1994). Therefore only data from Fiscal Years 1990/91 to 1993/94 will be used to determine current system operating costs.

The summary of O&M costs for the Resolute Bay facilities are contained in Table 5-1. The O&M costs fluctuate over the four years for individual facilities as well as for the entire water and sewer system. There are three main causes of these fluctuations as follows:

- two significant water main freeze ups occurred which were relatively costly to repair,
- the first year of the MMS system, 1990/1991, encountered normal implementation problems and the recorded O&M costs for that year are likely lower than they actually were,
- normal fluctuations in annual O&M requirements.

The average O&M cost per year for the facilities in Resolute is approximately $230,000. This average does not include the $187,000 cost for the Supply Line freeze up in 1992. For the purposes of this report, this cost is not a regular O&M costs and will be dealt with in Section 5.2.4 of this report.

5.2 PIPED SYSTEM OPTIONS

This section presents cost estimates to upgrade and maintain the existing piped water and sewer system in Resolute Bay for the next 20 years.

This report describes current deficiencies with the existing water and sewer systems which should be repaired or upgraded. These items have not been specifically allowed for in the life cycle estimate of the proposed water and sewer systems because these repairs and upgrades would likely be considered O&M costs. Therefore, historical O&M costs, which include some equipment replacement, should be sufficient for this and other work. Cost estimates for correcting these deficiencies are presented in Section 5.6 of this report for information only.

5.2.1 Capital (Upgrading) Costs

The capital upgrading costs of the existing facilities will include the various options described in Section 4.1 of this report. The capital costs for each option are summarized in Table 5-2 below. Estimate sheets of these cost estimates are contained in Appendix I.

TABLE 5-1

SUMMARY OF O&M COSTS FOR EXISTING FACILITIES

Fiscal Year	Char Lake Pumphouse					Signal Hill Plant					W/S Utilidor [A]				Comminutor Station				Total
	Inspections	Maintenance	Fuel	Electrical	Total	Inspections	Maintenance	Fuel	Electrical	Total	Inspections	Maintenance	Electrical[D]	Total	Inspections	Maintenance	Electrical[E]	Total	
90/91	$200	$9,800	$41,300	$36,400	$87,700	$500	$7,200	$26,900	$33,300	$67,900	$400	$14,300	$17,000	$31,700	$7,600	$2,500	$1,100	$11,200	$198,500
91/92	$500	$243,200	$43,100	$34,000	$320,800[B]	$300	$10,800	$37,500	$37,000	$85,600	$100	$26,400	$17,000	$43,500	$100	$2,200	$1,100	$3,400	$453,300(B)
92/93	$0	$33,700	$52,800	$18,200	$104,700	$0	$25,700	$47,500	$39,100	$112,300	$0	$5,400	$17,000	$22,400	$0	$6,400	$1,100	$7,500	$246,900
93/94	$800	$30,100	$41,700	$13,800	$86,400	$800	$16,400	$39,900	$31,100	$88,200[C]	$0	$28,300	$17,000	$45,300	$100	$7,000	$1,100	$8,200	$228,100[C]

NOTES:

(A) Includes building services.
(B) Includes $187,000 for supply line freeze-up.
(C) Includes $8,000 for supply line freeze-up.
(D) One year average of $77,000 from January 1, 1990 to June 14, 1994 (4.5 years).
(E) Estimated with comminutor ½ HP motor only load.

TABLE 5-2 CAPITAL COST ESTIMATES (1996 $) UPGRADING EXISTING SYSTEM					
Option	Upgrading Cost Estimates				
	Char Lake Pumphouse	Signal Hill Facility	Water and Sewer Mains	Sewage Disposal Continuous Discharge Lagoon	Total
1. Leave System As Is	$0	$0	$0	$0	$0
2. Partial System Upgrade	$0	$0	$466,400	$1,400,000	$1,866,400
3. Replace Entire Piped System and Upgrades to Remaining System	$0	$0	$3,711,000	$1,400,000	$5,111,000
4. Replace Entire Piped System with Above Ground Utilidor and Upgrades to Remaining System	$0	$0	$4,470,000	$1,400,000	$5,870,000

Table 5-2 contains values of $0 for capital costs for both the Char Lake and Signal Hill Facilities. The facilities should not require any upgrading at this time except for items at these facilities that are considered to be normal O&M costs as described above.

Values to construct a sewage lagoon have been included in Table 5-2 for all options, except leaving the system as is. As described in Section 3.6.5 of this report, we believe that the current dilution of sewage as a result of the system bleeders should be considered adequate treatment, and therefore further treatment should not be required. Improvements to the system would likely reduce the required bleeding rate which would reduce sewage dilution rates and thereby necessitate a further treatment process such as a lagoon.

5.2.2 Operation and Maintenance Costs

It is difficult to accurately predict O&M costs for a facility, particularly when upgrading an existing facility. The GNWT (MACA, 1986) uses a percent of construction costs to estimate O&M costs, however, for upgrading these facilities, it is expected that the more money spent on upgrading, the less money will be required for O&M.

In order to estimate the future O&M costs for these facilities, the O&M costs for the existing facilities, including the services for all buildings in the Hamlet serviced by the piped system, contained in Section 5.1 will be used. Estimated future O&M costs are contained in Table 5-3 below.

TABLE 5-3
OPERATION AND MAINTENANCE COST ESTIMATES (1996 $)
UPGRADING EXISTING SYSTEM

Option	Annual Operation and Maintenance Cost Estimates				
	Char Lake Pumphouse	Signal Hill Facility	Water, Sewer Mains and Service Lines	Sewage Disposal	Total
1. Leave System As Is	$108,000	$95,000	$37,100	$6,400[1]	$246,500
2. Partial System Upgrade	$108,000	$95,000	$21,000	$10,300[2]	$234,300
3. Replace Entire Piped System and Upgrades to Remaining System	$108,000	$95,000	$5,000	$10,300[2]	$218,300
4. Replace Entire Piped System with Above Ground Utilidor and Upgrades to Remaining System	$108,000	$95,000	$5,000	$10,300[2]	$218,300

[1] Existing Comminutor.
[2] Lagoon.

5.2.3 Life Cycle Costs

The life cycle costs of the options to retain a piped water and sewer system in Resolute Bay based on the above capital and O&M costs are contained in Table 5-4 below. These costs are for a twenty year life with an 8% discount rate.

TABLE 5-4
LIFE CYCLE COST ESTIMATES (1996 $)
UPGRADING EXISTING SYSTEM

Option	Upgrading Capital Cost (Total)	O&M Cost (Annual)	Life Cycle Cost (20 years at 8% Discount)
1. Leave System As Is	$0	$246,500	$2,614,000
2. Partial System Upgrade	$1,866,400	$234,300	$4,351,000
3. Replace Entire Piped System and Upgrades to Remaining System	$5,111,000	$218,300	$7,426,000
4. Replace Entire Piped System with Above Ground Utilidor and Upgrades to Remaining System	$5,870,000	$218,300	$8,185,000

According to Table 5-4, the piped system which has the lowest life cycle costs is leaving the system as is. These options are further evaluated based on economic as well as other criteria in Section 6.0 of this report.

5.2.4 Major Repairs

In addition to the estimated O&M costs for the facilities which are contained in Section 5.2.2 above, there may be some large unpredictable costs for these systems. These costs could result from freeze ups of large sections of piping, large pipe breaks (which could also result in frozen pipes) or physical damage to a facility (such as vandalism, 'act of God', vehicle damage, etc.) which would be infrequent yet costly. These items have not been factored into the O&M costs of the facility because they are not part of the normal O&M of a facility, they are not expected to occur and including them could skew the relative costs of the options.

Pipeline freeze up and/or failure repair costs are generally unpredictable; the cost of thawing a frozen line in 1992 was $187,000 and in 1993 was $8,000. However, there would be a greater chance for incurring these unpredictable costs by retaining the piped system in Resolute Bay due to the chance of a major freeze up in the piped system. If Resolute Bay converted to a trucked system, the Main Supply Line and piped distribution/collection system would be decommissioned and the likelihood of this type of freeze up happening should be significantly less or non-existent.

5.3 TRUCKED SYSTEM

The implementation and O&M costs for the water and sewer trucks, garage facilities and conversion of building service components of a fully trucked system for Resolute Bay have been estimated as per Appendix D of The General Terms of Reference for a Community Water and Sanitation Services Study (MACA, 1986). The O&M costs for the Char Lake and Signal Hill facilities are based on historic O&M costs, with adjustments for the lower water demand. Capital cost estimates for the remaining components which are not specifically covered in Appendix D of MACA, 1986, including conversion of facility for a truckfill point, construction of a sewage lagoon and decommissioning unused facilities, are summarized in estimate sheets in Appendix I of this report.

The trucked system was assessed with a number of options which include the following:

.1 Char Lake Pumphouse as the truckfill station
.2 Signal Hill Treatment Plant as the truckfill station
.3 constructing a new truck storage garage
.4 using existing storage space for overnight truck storage.

The cost estimate for the sewage disposal is based upon decommissioning the existing sewage disposal system and a lagoon being constructed near the shore of Resolute Bay.

The capital, O&M and life cycle costs for the facility are contained in Table 5-5 below.

TABLE 5-5
LIFE CYCLE COST ESTIMATES (1996 $)
CONVERSION TO A TRUCKED WATER AND SEWER SYSTEM

Item	Capital Cost	O&M Cost Per Year	Life Cycle Cost (20 years at 8% Discount)
1. Conversion to Truckfill			
1. Char Lake	$71,200	$74,000	$856,000
2. Signal Hill	$236,450	$141,000[A]	$1,732,000
2. Water and Sewer Trucks[B]			
1. Char Lake as Truckfill	$175,000	$169,500	$1,972,000
2. Signal Hill as Truckfill	$175,000	$156,800	$1,838,000
3. Garage Facilities			
1. New	$400,000	$24,000	$655,000
2. Use Existing	$0	$0	$0
4. Conversion of Building Services	$585,000	$11,700	$709,000
5. Sewage Lagoon	$800,000	$10,300	$909,000
6. Decommissioning Facilities			
1. Char Lake as Truckfill	$75,000	$0	$75,000
2. Signal Hill as Truckfill	$65,000	$0	$65,000

[A] Includes $74,000 for Char Lake.
[B] Includes operators.

The total life cycle cost for a trucked water and sewer system for each of the options discussed above are contained in Table 5-6 below.

TABLE 5-6
TOTAL LIFE CYCLE COSTS (1996 $)
FOR A TRUCKED WATER AND SEWER SYSTEM

Option	Life Cycle Cost (20 years at 8% Discount)						
	Truckfill Building Conversion	Water and Sewer Trucks	Garage Facility	Building Services Conversions	Sewage Lagoon	Decommission Facilities	Total
1. Char Lake as Truckfill New Garage	$856,000	$1,972,000	$655,000	$709,000	$909,000	$75,000	$5,176,000
2. Char Lake as Truckfill Use Existing Building as Garage	$856,000	$1,972,000	$0	$709,000	$909,000	$75,000	$4,521,000
3. Signal Hill as Truckfill New Garage	$1,732,000	$1,838,000	$655,000	$709,000	$909,000	$65,000	$5,908,000
4. Signal Hill as Truckfill Use Existing Building as Garage	$1,732,000	$1,838,000	$0	$709,000	$909,000	$65,000	$5,253,000

As shown in Table 5-6, the trucked water and sewer system with the lowest life cycle cost utilizes the existing Char Lake Pumphouse as a truckfill facility and existing storage space as garage space for the trucks.

5.4 PHASING IN TRUCKED SYSTEM

If conversion to a trucked system is determined to be the preferred option for future water and sewer services in Resolute Bay, deferring capital expenditures is possible by phasing the conversion. The issues to consider in determining the number of years over which the conversion is to be phased are described in Section 8.0 of this report.

The estimated capital and O&M costs to phase construction over three and five year periods and to complete construction in one year are presented in Table 5-7. The life cycle costs were assessed over five years only because annual costs after the five years would be the same for each option and would therefore not affect the value of the differences between life cycle costs.

As shown in this table, the present (1996) value of the additional cost to phase construction over three years is approximately $87,000 and over five years is $181,000.

TABLE 5-7
TRUCKED SYSTEM PHASING COST ESTIMATES

Year	Capital Cost Estimates	O&M Cost Estimates		Total
		Trucked	Piped	
SINGLE YEAR CONSTRUCTION				
Year 1	$1,706,000	$132,800	$123,300	$1,962,100
Year 2	$0	$265,500	$0	$265,500
Year 3	$0	$265,500	$0	$265,500
Year 4	$0	$265,500	$0	$265,500
Year 5	$0	$265,500	$0	$265,500
TOTAL (1996 $ at 8% Discount)	$1,706,000	$1,012,200	$123,300	**$2,841,500**

(Continued)

TABLE 5-7 (Continued) TRUCKED SYSTEM PHASING COST ESTIMATES				
Year	Capital Cost Estimates	O&M Cost Estimates		Total
		Trucked	Piped	
THREE YEAR PHASED CONSTRUCTION				
Year 1	$1,238,000[A]	$35,400	$246,500	$1,519,900
Year 2	$209,000[B]	$100,900	$246,500	$556,400
Year 3	$284,000[C]	$161,300	$123,300	$568,600
Year 4	$0	$265,500	$0	$265,500
Year 5	$0	$265,500	$0	$265,500
TOTAL (1996 $ at 8% Discount)	$1,675,000	$673,000	$580,500	**$2,928,500**
FIVE YEAR PHASED CONSTRUCTION				
Year 1	$1,168,000[A]	$23,300	$246,500	$1,437,800
Year 2	$127,000[B]	$64,700	$246,500	$438,200
Year 3	$127,000[B]	$100,900	$246,500	$474,400
Year 4	$127,000[B]	$137,100	$246,500	$510,600
Year 5	$202,000[C]	$173,400	$123,300	$498,700
TOTAL (1996 $ at 8% Discount)	$1,643,800	$406,000	$972,400	**$3,022,200**

A Converting Char Lake to truckfill, purchasing trucks, converting some buildings and construction of sewage lagoon.

B Building conversions and mobilization/demobilization costs.

C Building conversions, mobilization/demobilization costs and decommissioning.

5.5 HEATING COSTS

The exterior paint on both the Char Lake Pumphouse and Signal Hill Water Treatment Plant has deteriorated and should be redone. To assess potential heating cost savings for the Pumphouse and Treatment Plant as a result of adding insulation to the buildings versus only repainting the existing buildings, the life cycle costs of each option were estimated. These costs were not included in the life cycle cost analysis for trucked versus piped systems because they are not a requirement of either system and are therefore an independent issue. The estimated costs are contained in Table 5-8.

TABLE 5-8 BUILDING HEAT LIFE CYCLE COST ESTIMATES (1996 $)				
Building	Condition	Capital Cost	Annual Fuel Cost[1]	Life Cycle Cost (20 Years at 8% Discount)
Char Lake	Repaint	$11,400	$5,100	$65,480
	Insulate	$27,800	$3,600	$65,970
Signal Hill	Repaint	$10,560	$7,400	$89,030
	Insulate	$26,120	$5,300	$82,320

[1] Estimated cost to heat building only.

The capital cost estimates for adding insulation to the building includes the cost of installing new combustion air intake ducting complete with two-position dampers. These will be required due to the new insulation sealing existing cracks and other sources of natural ventilation. Upgrading the existing ventilation system could also be investigated to provide adequate combustion air.

The life cycle costs in Table 5-7 indicate that the options to add insulation to the Char Lake and Signal Hill buildings have slightly higher life cycle costs than simply repainting these facilities. These estimated life cycle costs are applicable to both piped and trucked servicing.

5.6 CORRECTING EXISTING DEFICIENCIES

Section 3.7 contains a list of recommended upgrades for the existing facilities if they are to continue being used. Most of these items are considered O&M work and therefore are not included in the previous cost estimates. The estimated costs for these upgrades are contained in Table 5-9.