

Waste Treatment in Northern Canada

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Pollution control in the Canadian north presents many unusual and difficult problems. The most difficult and also the most important of these is the design of piped sewage collection systems. The design of suitable sewage treatment facilities is simpler, but more difficult, due to low temperatures and associated phenomena, than in warmer climates. The planning and design of piped sewage collection systems must be integral components of the overall community plans, because of the high costs and greater dependence on topography and ground conditions in the north.

SEWAGE TREATMENT

Secondary treatment of sewage has been set as the objective in the Canadian north. However, because of the casual way in which drinking water is so often taken, the most important criterion for sewage effluent is its bacteriological quality.

Our experience to date has shown that long-retention sewage lagoons have been the only successful and economical method of community waste disposal practised in the Northwest Territories to date. The use of lagoons is expanding because of high capital, power, heating, and operating costs necessary for other types of treatment processes, (e.g. activated sludge, extended aeration and physical-chemical) and because of the difficulties in obtaining reliable, competent operators and in providing the necessary supervision by the regulatory authority.

We recognize that a well-designed and well-operated treatment plant would provide a high quality effluent, but our experience with extended aeration plants in the north leads us to question the advisability of using such plants unless a satisfactory operator is absolutely assured. There will, however, be places where there is insufficient space for lagoons. The Canada Ministry of Transport imposes restrictions on the siting of lagoons near airports. In such cases, treatment plants will be required.

The basic objective of a lagoon is that it should provide an effective method of wastewater disposal without creating objectionable conditions or public health hazards in the receiving water source.

Limited studies of sewage lagoons at Inuvik and Yellowknife, N.W.T.¹ have shown that long-retention sewage lagoon treatment is a satisfactory method of domestic sewage disposal for small northern settlements. The study lagoons are covered with ice eight months of the year. Winter temperatures frequently drop to 50°F for extended periods. Both lagoons also have serious construction deficiencies which interfere with their operation; i.e. emergent growths, uneven bottoms, shallow areas, irregular shaped berms and inlets close to berms, however, they provided satisfactory degrees of treatment.

Comparison of the operation of a single cell system with a combination short-retention and long-retention system at Yellowknife showed that the combined system had the advantage of better efficiency in winter and simplified inflow sewer design.

The results of recent examinations of the lagoons in the Mackenzie District are summarized in Table 1. In general, BOD₅ and coliform reductions are greater in summer than in winter. There is negligible biological activity in a sewage pond during the winter, but during the summer when the sun shines 24 hours per day, the

activity is accelerated. The solids reductions are generally greater in winter. This is because the very heavy algae growths in summer are included in the suspended solids analysis and to a lesser extent because, in winter, ice cover protects the lagoon from wind currents which may disturb sludge deposits.

These recent examinations of lagoon operations in the north have substantiated previous proposals for design criteria in arctic and subarctic regions.² In most cases, a sewage pond, which provides a year's retention time, is suitable. The sewage is stabilized during the summer months and then discharged.

The Province of Alberta, Department of Environment has shown that a sewage oxidation pond system of at least two cells, providing a total of 24 months' retention will provide a very high quality effluent almost free of coliforms and very low in suspended solids, BOD₅ and nutrients such as nitrogen and phosphorous.³ Twenty-four months' retention is now a standard requirement in ecologically sensitive areas in the Province of Alberta.

Sewage lagoon effluent could be used for irrigation particularly in the high arctic where the ground is very barren. Even the

TABLE 1. Summary of Oxidation Pond Installations, Mackenzie District, Northwest Territories.

Location	Latitude	Tributary Popu.	Sewage Flow Daily ig	Per Capita igpcd	Lagoon Type	Average Depth ft.	Area acres	Loading lb BOD ₅
Inuvik	68°21'N	1,500	190,000	127	Single Cell Long Retention	4	43.5	392
Norman Wells	65°N	----	----	----	Single Cell Short Retention, Following Septic Tank	2	0.01	49
City of Yellowknife	62°N	3,500 ('66)	373,000	110	Combination 1 day Short Retention Long Retention	12	0.1	534
		6,000 ('70)	699,200	117		3.2	21.0	636
Yellowknife Correctional Camp	62°N	44	1,440	----	Single Cell Long Retention, Following Extended Aeration Plant.	3	0.09	----
Hay River	60°50'N	1,200	180,000	150	Two Short Retention Cells	12	0.263 each	135
Pine Point	61°40'N	900	135,000	150	Two Short Retention Cells	6 3	1.67 0.75	113 ----
Town of Fort Smith	60°N	2,000	100,000	50	Single Cell, Long Retention	4	10	215
Fort Smith Airport	60°N	120	4,500	----	Single Cell Long Retention	6	1.1	111

TABLE II. Summary of Oxidation Pond Installations, Mackenzie District, Northwest Territories

LOCATION	Loading		Theoretical Retention Time (Days)	Efficiency					
	lb BOD ₅ /3,000 ft ³ /d	lb BOD ₅ /acre/d		BOD % Reduction		SOLIDS % Reduction		COLIFORM % Reduction	
				Summer	Winter	Summer	Winter	Summer	Winter
Inuvik**	----	9	180 Summer* 300 Winter	85	45	91	90	99.9	99.8
Norman Wells**	----	49	23	67	----	----	----	----	----
City of Yellowknife**	14.8 17.7	----	0.6 & 49 0.3 & 26	73 59	60 39	91 ----	98 69	99.99 ----	97.7 ----
Yellowknife Correctional Camp**	----	----	52	----	----	----	----	----	----
Hay River**	3.07	513	1.5 Each	41	43	69	81	----	----
Pine Point**	----	68	17 5.3	30	42	15	82	----	----
Town of Fort Smith***	----	21.5	110	87	53	95	72	----	----
Fort Smith Airport***	----	10	365	80	21	46	56	99.99	----

* - Retention time reduced by surface runoff to lagoon.

** - Continuous effluent discharge.

*** - Periodic effluent discharge.

“fragile” tundra may benefit from the nutrients in a lagoon effluent.

Where effluent is to be disposed of into a salt-water sea, secondary treatment may also be given low priority because of its high cost. Fundamentally, the most important objective is the removal of visible solids and the location of the outfall point so as to avoid pollution of the beaches where people dock their boats, etc. However, the eventual objective should be to provide secondary treatment.

GARBAGE DISPOSAL

In southern Canada, low land is commonly chosen for disposal sites. In permafrost regions low land is wet on the surface in summer and frozen below the surface. Therefore, such sites are inaccessible in summer and it is virtually impossible to compact and cover the garbage. Even if the garbage were to be buried, it would be frozen and its decomposition would be very slow. Therefore, the best disposal site is on high land. If a site is chosen over the brow of a hill, it may be conveniently close, while being out of the sight of the residents.

Combustible material, which makes up the bulk of the refuse, should be segregated and burned at the site rather than being burned in garbage cans in the community. The non-combustible material should be compacted and covered at intervals. The general lack of soil makes this an objective that is seldom realized.

Incinerators that are well designed and operated provide superior disposal. However, they may be too expensive for general use in the north, except for example in oil drilling camps, because the oil companies are anxious to create a favorable image.

INDUSTRIAL POLLUTION

Industrial pollution is confined to mining wastes and occasional oil spills. Arsenic and lead are two mineral pollutants which have caused some problems, but these have not been insurmountable. The control of oil pollution is more difficult because of the use of the less expensive bolted tanks rather than welded steel tanks for fuel oil storage in northern settlements. Also, the soil conditions are usually very poor both for providing stable foundations for the tanks and for making

oil-tight berms around the tanks to contain oil spills.

SEWERS

The most difficult problem in northern communities is the provision of sewers. The laying of sewers is very expensive in cold regions and the problem has been aggravated by the almost total neglect of this consideration in the initial planning of northern communities. Experience has shown that if sewers are not considered in the earliest stages of community planning, then sound engineering of sanitary services is not possible.

In non-sewered communities, pollution is in its worst form, namely, around the houses. Water and sewage are hauled respectively to and from government employees' residences, schools and offices which have complete internal-plumbing systems and holding tanks. The other houses have water delivered to storage barrels. The toilet sewage is hauled away in plastic bags. Other inferior individual household waste disposal systems also exist including pit privies, bucket toilets, recirculating flush, economy flush and

incinerating toilets. Various attempts at subsurface disposal of septic tank effluent have also been tried from time to time, but these have usually been unsuccessful. Liquid wastes are spilled outside of those residences without plumbing and sewage-holding tanks; and because the ground surface is frozen for most of the year, the liquid does not seep away.

In the spring, the melted wastes combine with the snow melt in a settlement to form pools around the houses and bigger pools in the upper road ditches which are usually dammed by ice-choked culverts. Children play in this polluted water and mosquitoes breed prolifically.

The very best of homes in the north are quite modest and the occupants are frequently troubled by freeze-ups and other breakdowns in the sewer and water systems. However, the differences between homes in unserved and served areas of a settlement and the effective segregation which results are creating serious social problems in many northern communities. Sewers are an absolute necessity for a community if it is to become a pleasant place to live.

COMMUNITY PLANNING

Imaginative community planning

provides a key to the solution of many of the problems.

A number of community planning and engineering concepts have been proposed^{4,5} to reduce the cost of providing piped sewage collection systems. Consolidation of a community reduces the length of utility services and hence the cost. Careful use should be made of the topography in order to provide suitable gradients and layout for a gravity sewer system, which, in permafrost areas, may need to be laid either in above-ground utilidors or in shallow burial. This is very important because lift stations are particularly expensive to install in the north, and both very costly and difficult to maintain. Collector sewers in utilidors should run from one building to the next instead of existing as a stem with service branches.

It is not difficult to build pleasant districts or small communities for affluent people, however, it requires careful planning to build a community where the rich and the poor, the natives and the non-natives, and the administrator and his subordinates can live together in harmony. It will take more than just removing the pollution from the backyards, but that is a necessary first step.

This paper was presented by Grainge and Shaw at the recent 22nd Alaskan Science Conference held at the University of Alaska during August 17-19, 1971.

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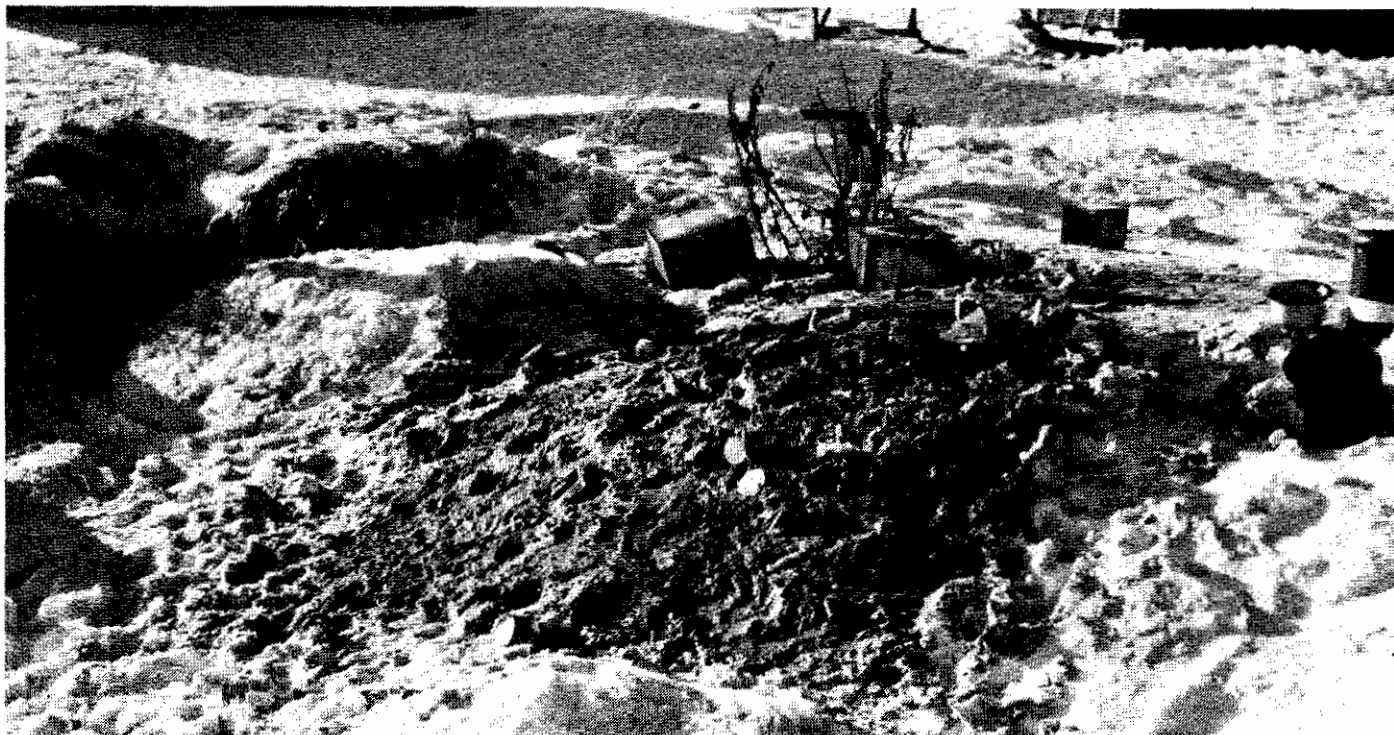
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In non-sewered communities, pollution is in its worst form, namely, around the houses. (Photo by Amos J. Alter)