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Agricultural and Food Processing Waste Treatment and Disposal

Seminar Proceedings

Solid Waste Management
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Agricultural and Food Processing Waste Treatment and Disposal

Seminar Proceedings

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Halifax, Nova Scotia

ABSTRACT

On November 26, 1974 a seminar was held in Halifax, Nova Scotia which dealt with the disposal of organic wastes on land. The seminar, "Agricultural and Food Processing Waste Treatment and Disposal" was organized jointly by the Atlantic Regional Office and the Solid Waste Management Division of Environment Canada's Environmental Protection Service.

Four guest speakers presented papers on some of the most important aspects of this subject. The speakers were:

1. Professor L.R. Webber
   Department of Land Resource Science
   University of Guelph
   Guelph, Ontario

2. Mr. F.R. Hore
   Engineering Research Service
   Agriculture Canada
   Ottawa, Ontario

3. Mr. Vaclav Kresta
   Pollution Control Branch
   New Brunswick Department of Fisheries and Environment
   Fredericton, New Brunswick

4. Mr. W.C. Phillips
   Air and Solid Waste Management Division
   Environmental Control Commission
   Charlottetown, Prince Edward Island

Soils possess a natural capacity to interact with chemicals released from various kinds of wastes. In his paper, Professor Webber discusses the properties of a soil which determine the feasibility and limits of using land as a waste disposal medium.

Present-day animal manure management practices related to storage, transportation and incorporation on land are discussed by Mr. Hore. Although the processing of manure to reduce some of its objectionable properties is not widely practiced, those systems which are presently in some stage of development or use are discussed in some detail.

The food processing industry generates organic wastes which are commonly deposited in land disposal sites. Mr. Kresta discusses this practice, particularly with reference to the food processing industry in the Maritime Provinces.

The advantages and disadvantages of employing various control techniques to regulate the disposal of organic wastes on land are outlined by Mr. Phillips. This is followed by a group discussion of guidelines which might be adopted.

RÉSUMÉ

Le 26 novembre dernier, il s'est tenu à Halifax (N.-É.) un séminaire sur l'évacuation des matières organiques sur les sols. Ce séminaire avait pour thème le traitement et l'élimination des déchets produits par l'agriculture et l'industrie alimentaire; il fut organisé conjointement par le Bureau régional de l'Atlantique et la Division de la gestion (déchets solides) du Service de la protection de l'environnement, Environnement Canada.

Quatre conférenciers invités ont présenté des rapports sur quelques-uns des plus importants aspects du sujet:

1. M. L.R. Webber
   Département des sciences des ressources terrestres
   Université de Guelph
   Guelph (Ontario)

2. M. F.R. Hore
   Service des recherches techniques
   Agriculture Canada
   Ottawa (Ontario)

3. M. Maclav Kresta
   Direction de la lutte contre la pollution
   Ministère des Pêches et de l'Environnement du Nouveau-Brunswick
   Fredericton (Nouveau-Brunswick)

4. M. W.C. Phillips
   Division de la gestion de l'air et des déchets solides
   Commission de la surveillance de l'environnement
   Charlottetown (Île-du-Prince-Édouard)

Les sols réagissent naturellement aux différents produits chimiques présents dans les déchets. L'étude du professeur Webber traite des propriétés pédologiques caractérisant les possibilités de se servir des sols comme milieu d'évacuation des déchets, de même que les limites à cet égard.

Le sujet abordé par M. Hore porte sur la gestion applicable aux fumiers du point de vue de leur entreposage, de leur transport et de leur épandage sur les sols. Le traitement des fumiers pour en éliminer certaines de leurs propriétés indésirables n'est pas tellement fréquent, mais certaines méthodes sont déjà au point ou utilisées dans une certaine mesure.

L'industrie alimentaire produit des déchets organiques qui sont souvent évacués sur les sols, aspect dont traite M. Kresta, en s'appuyant notamment sur l'industrie alimentaire des Maritimes.

Quant à M. Phillips, il décrit les avantages et les inconvénients des divers moyens de régir l'évacuation des déchets organiques sur les sols. Le tout se termine par une discussion en groupes des lignes directrices qui pourraient être adoptées.

FOREWORD

Ever since man first domesticated animals and learned how to make the land bring forth food, he has had to cope with the disposal of certain inedible and unusable by-products of these activities.

Modern-day agricultural and food production practices have created situations where large volumes of wastes are produced which often exceed the localized natural capacity of the soil to assimilate them. Nevertheless, the bulk of these organic wastes continues to be deposited on the land.

Thus, control measures must be developed and implemented to prevent adverse effects on water, air and land which could endanger the health of man and other living organisms.

This seminar brings together the farming community and environmental interests in an effort to define the problem, better appreciate how it may be controlled, and hopefully, reach a common understanding of the best, practical control measures applicable to various situations.

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OPENING REMARKS

Mr. L.P. Fedoruk

Head, Federal Activities Protection

Environmental Protection Service

Environment Canada

Halifax, Nova Scotia

Good morning, ladies and gentlemen. I would like to welcome you to Halifax for those of you who don't come from this fair city.

We are quite fortunate to have four speakers today, the first being Professor Leonard Webber. He is a Professor of Soil Science at the University of Guelph in Guelph, Ontario. He has received his BSA degree in Chemistry from the Ontario Agricultural College, and his MS degree from Cornell University where he specialized in soil physics. Professor Webber has been closely associated with teaching, research and the advisory sciences at the University. He developed a farmland use planning science, organized and taught the first formal courses in soil conservation, soil physics and environmental quality. He was the initial chairman of the Animal Waste Committee and the inter-disciplinary group on research people concerned with animal waste treatment, utilization and disposal. He is a member of the Ontario Pesticide Committee, an advisory body for the province and a member of the National Research Council Committee on Urban Engineering Terrain Problems. His research activities are concerned with the use of land for waste disposal and utilization. Professor Webber.....

SOIL AS AN ACCEPTOR OF WASTE

Professor L.R. Webber

Department of Land Resource Science

University of Guelph

Guelph, Ontario

INTRODUCTION

Thank you. I must say it is a pleasure, Mr. Chairman to be here.

Ladies and gentlemen the topic I have been asked to talk on this morning is soil as an acceptor of wastes.

In spite of the long history of waste disposal on land, research has not fully defined the limitations and potential hazards associated with the practice. The application of wastewater to the land as an alternative to more conventional methods of wastewater management has become an emotionally charged and controversial topic in the U.S.A. (9). One author noted that: In the short span of four years, the practice of land disposal has been raised from near extinction to a position of national eminence (5). I think in that case they were referring to the Muskegon project in Michigan where they are taking several thousands of acres for the disposal of wastes from another several hundred thousands of people.

The primary function of land is the production of food and feed for humans and livestock but as the earth's population continues to increase, more and more people urge that land be used for the disposal of their wastes. If we accept the opinion that the expansion of agriculture into new lands has just about ended, then man's management of land already developed is crucial. It is a prime requisite of any disposal system that a waste from one medium be prevented from causing pollution elsewhere. If we propose to use land as a receptor of wastes, then our ultimate objective must be to utilize or dispose of wastes on soils in such a manner that the practice does not impair the quality or quantity of food produced.

SOIL PROPERTIES AND WASTE DEGRADATION

Soils possess an inherent capacity to provide a medium for the oxidation, reduction, fixation and release of compounds from applied wastes.

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There are many properties and processes in a soil that determine the feasibility of using land as a waste disposal medium.

Soil Aeration and Drainage

The kind and extent of microbial degradation of wastes containing organic materials and the subsequent release of by-products are determined in part, by soil aeration and the oxygen status. Soils that are naturally well-drained provide an aerobic environment for waste decomposition. In the presence of free oxygen, many carbonaceous compounds are oxidized to simpler and more stable states and simulataneously produce energy.

The utilization of sludge or organic wastes on agricultural soils involves the fate of many elements and compounds. Of particular interest is the fate of the nitrogenous compounds. Under appropriate conditions, notably an aerobic environment, many organic nitrogenous materials are transformed to ammonium-nitrogen or nitrate-nitrogen. The nitrate ion is mobile and moves freely with the soil solution; the ammonium ion may become part of the soil cation exchange complex and subsequently oxidized to the nitrate form or be absorbed by plants. Similarly, the oxygen status of a soil determines the level of oxidation of several metallic elements, such as iron and manganese.

Under temporary or sustained anaerobic conditions in a soil, the initial and intermediate products of decomposition are unoxidized. Many products from the anaerobic degradation of organic wastes are characteristically foul-smelling and may inhibit plant growth. That is, from the anaerobic decomposition we can get excess concentrations of ammonia which will interfere with seed germination and plant growth. The incomplete oxidation of nitrogenous compounds results in an accumulation of ammonium nitrogen in the soil profile or in the percolating waters. When oxygen becomes limiting and an energy source is available, significant losses of nitrogen occur by denitrification. These biological processes effectively reduce nitrogen in the nitrate form to gaseous nitrogen, N_2. Considerable research is required to adequately determine the magnitude of the losses by denitrification and eventually, in some situations, use the process advantageously.

Soil Texture and Permeability

Some time ago, it was noted that the most effective use of soil for waste disposal involves two apparently incompatible functions: the ability to accept large volumes of waste and the ability to provide good treatment. Coarse gravel satisfies the first function, but not the second; silt and clay soils may satisfy the second, but not the first (1).

A knowledge of and an appreciation for soil permeability under natural or field conditions are indispensable in planning for the disposal of wastewaters on soils. Permeability coefficient refers to the capacity of a soil to transmit water and air. The soil profile, usually to a depth of five feet or more must be considered in assessing soil permeability. Some surface soils exhibit a greater capacity to transmit water (the infiltration rate) than subsoil layers or strata.

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Numerous publications exist which detail techniques for the determination of permeability under field conditions. The methods involve the use of piezometers, auger hole and tube and the conventional undisturbed-core method. Generally, these methods are time-consuming, hence expensive, and subject to relatively large coefficients of variation. Significant correlations were found between permeability rates, and soil structure and a general lack of correlation with bulk density and soil texture. (4)

In an article for engineers, we tried to make a very strong point that the permeability as estimated by soil surveyors was the most meaningful value (7). Details of soil structure, including type, grade and class as well as consistence are normally recorded in survey reports. These data along with texture, profile irregularities such as pans and channels provide a body of characteristics that in general permit a soil surveyor to evaluate soil permeability. The converse of using the soil surveyor's value of course, is to take other values that <u>some</u> engineers say "Well, from our experience we know this is the value: It's 10^{-3} and 10^{-5}" without actual determinations. Both methods are questionable, there's no doubt about that, but there is a problem there in knowing what the permeability of a soil is.

Exchange Capacity of Soils

A soil exhibits a physical-chemical property of adsorbing positively charged ions to the negatively charged clay micelles and the soil organic matter. Cations are not held with equal security and usually follow the series $H^+ > Al^{3+} > Ca^{2+} = Mg^{2+} > K^+ = NH_4^+ > Na$.

Under field conditions an equilibrium exists between the soluble ions in the soil solution and the ions on the adsorption sites. The quantity of an ion adsorbed depends in a large part on its concentration in the solution phase. Because sodium (Na) has a low adsorption affinity, it is not likely to be adsorbed in excess unless its concentration exceeds the combined concentration of Calcium Ca^{2+} and Mg^{2+}.

For several years, we have monitored the exchangeable cation status of soils in Ontario used for the disposal of sodium and potassium wastes from lye-peeling operations in vegetable processing plants. The lye in this case, of course, was sodium hydroxide.

The percentage saturation of the cation exchange complex by sodium has been determined since 1971, usually twice a year, and the data are shown in Table 1.

TABLE 1

Percentage Saturation of the Cation Exchange Complex By Sodium for Seven Times of Sampling

Depth	Sodium Saturation *						
	1971		1972			1973	1974
	Fall	Spring	Summer	Fall	Spring	Fall	Spring
0-10"	6.56	1.84	4.85	7.34	7.57	6.63	3.83
33-54"	4.60	3.87	2.77	4.02	4.60	18.40	7.26

* Saturation expressed as a percentage of the cation exchange capacity occupied by sodium.

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You will see that in the Fall of 4 years, the percentage of the exchange complex occupied by sodium reaches its peak value. This is because we sampled shortly after the alkali or the lye waste had been applied to the soil. We came back in the Spring, after we had had the rain and the snow for the natural leaching processes, and found that the same soils probably reached their minimum value in the early Spring. When the surface soil is at a low degree of exchangeable sodium there is a higher concentration with depth. In other words, the sodium from the surface layer has been leached out of the surface down to lower depths.

In soils having free calcium carbonate or pH 7 or above, hyrolysis occurs with free calcium ions being brought into solution. For this reaction to occur, soil water is required. Presumably, less free calcium is released if the calcium carbonate equivalent of the soil is low or if the pH is particularly high due to sodium compounds in the soil solution. The hydrolysis of the calcium carbonate and the replacement of sodium on the exchange complex by the free calcium is shown in the following equation:

$$2NA_{ad} + CaCO_3 + H_2O \rightarrow CA_{ad} + 2NA^+ + HCO_3^- + OH^-$$

In an interpretation of the above reaction it was pointed out that the reaction proceeds to the right as the water content of the soil is increased (3). If the soil is leached and if sufficient $CaCO_3$ is present the reaction continues to the right owing to the removal of the HCO_3^- and OH^- and Na^+ until the adsorbed sodium (Na_{ad}) is replaced.

Calcium carbonate alone is generally an ineffective source of calcium in soils with a high pH (>8.5) because of the low solubility of the carbonate. In some arid salt-affected soils with an excess of lime, the replacement of sodium by calcium is effected by the addition of elemental sulphur. Soil organisms oxidize calcium sulphate. The addition of calcium sulphate is equally effective in inducing the exchange of sodium for calcium.

We tend to accept the American value that if more than 15% of the soil's exchange complex is saturated with sodium then we could be in trouble. The soil colloids will be dispersed, aggregation is likely to be destroyed, permeability will be severely restricted, and in general, a poor physical condition would result. That's when you have 15%. As I say, in some of the work we have done, in Ontario, so long as we have a supply of calcium carbonate there, and over the four year period, the exchangable sodium does go up to a peak and comes down, goes through a cyclic nature.

Soil Nitrogen and Phosphorus

When wastes are applied to a soil as a liquid, slurry or solid it is essential to know the chemical characteristics of the wastes, particularly the carbon, nitrogen and phosphorus contents.

Nitrogen and the Carbon to Nitrogen Ratio

Of the many chemical relationships in a soil, the carbon to nitrogen ratio (C/N) is of major importance when considering the use of soil for waste disposal or nutrient recycling. To utilize carbon in the production of new bacterial cells, the soil micro-organisms require a certain amount of nitrogen. An optimum C/N ratio is a function dependent upon the amount and availability of the carbon to the micro-organisms. When the amount of nitrogen in a waste is low relative to the carbon content, that is a C/N > 30, the carbon assimilation is low and slow and the available soil nitrogen is immobilized by the soil organisms. Nitrogen immobilized by the organisms is not immediately available to plants. On the other hand, nitrogen in wastes is released rapidly to a soil if wastes with a low C/N ratio, (<10) are added to a soil.

In this case, you have to think of two extremes: adding pulverized garbage to the soil with a carbon to nitrogen ratio the order of 65:1 or adding sewage sludge with the carbon nitrogen ratio of 5:1. Those are the two extremes we are thinking about.

Nitrogen that is not immobilized by soil micro-organisms or not recovered by a crop, may be lost from the soil by leaching or as a gas (N_2) by denitrification or retained on the soil exchange sites as ammonium nitrogen. Additions of nitrogen to ground or surface waters in abnormal amounts may contribute to lake eutrophication or result in water too high in nitrates for consumption by man or animals.

The role of the C/N ratio and its effect on immobilization and subsequent release of nitrogen when carbonaceous wastes are applied to a soil are illustrated (10). The carbon and nitrogen contents of the wastes are given in Table 2.

TABLE 2

Concentration of Carbon and Nitrogen in Solid Waste, Anaerobic Sludge and Liquid Poultry Manure

	Solid Waste	Sludge	Manure
Carbon, percent	37.1	1.26	1.01
Nitrogen, percent	0.57	0.26	0.44
C/N Ratio	65:1	4.6:1	2.3:1

There again it is simply a matter of looking at the carbon to nitrogen ratio of the shredded garbage of 65:1 and of the sludge of 5:1 and liquid poutry manure in the order of about 3:1. Wide extremes. In the field trials that followed this experimentation, we added the sludge to the ground-up garbage and we added the liquid poultry manure to the ground-up garbage to try to narrow this carbon to nitrogen ratio.

The kinds of amounts of waste applied to and mixed with surface soil have been detailed. The wastes, the shredded garbage and the sludge, were applied in August. They were allowed about 6 weeks to sit there, go through some form of decomposition and then in mid-September the area was seeded to winter rye. This was done for two purposes: to pick up any nitrate nitrogen that might have been released and to prevent any run off erosion because it was on a sloping hillside. We sampled this rye in November, after it had been frozen, and then the following May the rye was disced under and the whole area seeded to corn. So, we've gone through about a yearly cycle where the wastes were applied, some attempt was made to adjust the C/N ratio and we planted the rye for the reasons that we grew the crop of corn. The data in Table 3 indicate the nitrate-nitrogen content of the rye in November and the quantity of nitrate-nitrogen remaining in the soil after corn harvest in October.

TABLE 3

Details of Waste Treatments, Nitrate Content of Fall Rye and Nitrate in Soil After Corn Harvest

Treatment	NO_3-N in rye (%) sampled in Nov.	NO_3-N in soil (kg/ha) after corn harvest
Control, no waste added	0.50	92
Solid waste, 280 MT/ha	0.14	184
Sludge 2.3 cm	0.98	216
Solid waste, 280 MT/ha plus 2.3 cm sludge	0.50	284
Solid waste 560 MT/ha plus 4.6 cm sludge	0.26	236
Solid waste, 280 MT/ha plus 1.4 cm manure	0.65	240

One thing that concerns the livestock industry when we talk about the application of large amounts of organic wastes that contain nitrogen, such as domestic sewage sludges from the water pollution control plants, or animal wastes is the nitrate nitrogen content of that forage. We tend to accept one of the higher values that appear in the literature and that is if the nitrate nitrogen content of that crop is 0.3% or greater, that is 300 parts per million, that is the absolute upper limit that this forage should be fed to livestock. Otherwise you are going to get nitrate poisoning in the livestock.

In our experiment where we added these mixtures, the nitrate nitrogen in the rye that grew on the shredded garbage without a nitrogen amendment was well below the 0.3 value. In fact it was 0.14. Where we added about an inch of liquid sludge to the soil, no additional carbon, that is a low CN ratio, and the nitrogen was released very quickly. We had 0.98 or almost 1% of that rye crop by weight in the nitrate form. So therefore, you just wouldn't permit livestock to graze unrestricted on that nor would you feed it to livestock unrestricted. You'd mix something else with it.

In fact, most of the treatments where sludge was used, had nitrate nitrogen in excess of this 0.3 value. Certainly the C/N ratio was one of the things that affected it. In addition, this rye was sampled in November; it had gone through a period of freezing and thawing and it is known that that will change the nitrate nitrogen content of a crop. It is also known that once the lush green vegetation is frozen most of the soluble phosphorous in the plant cells is released and can occur as run-off water. There are some excellent studies in Minnesota on that.

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We then turned the rye under in May and planted the crop of corn. The nitrogen remaining in the soil after the corn was harvested in September was again rather surprising. We had more nitrogen there than we needed to produce the crop. In fact, we had an excess left over for most of the treatments. By that time the shredded garbage and the source of nitrogen, either the poultry manure or the sewage sludge, had been in the soil just over one year.

A lot of decomposition had taken place and a lot of nitrogen had been immobilized but, equally a large amount of nitrogen was still in the soil profile. We ended up having in some cases about 250 and more pounds of nitrate nitrogen in that soil to a depth of 90 centimeters or 30 inches. It was not used by the crop.

One of the things we believe that stimulated the production of nitrate nitrogen was the practice of plowing under this green rye in the Spring. It has been established by data in the literature that where a lush green material is plowed under it stimulates the micro-biological activity and you generate a large amount of nitrate nitrogen.

Some of the conclusions from this field experiment were that:

1. The level of NO_3-N in the rye could be hazardous if fed to or grazed unrestricted by livestock (0.3 percent proposed as the upper limit).

2. An evaluation of a practice of interseeding the corn with a crop of rye or fall wheat that would utilize soil nitrogen remaining after corn harvest.

That was pretty well established practice in parts of Ohio and southern Pennsylvania back in the old days of Soil Conservation Service to control erosion. They would go in with narrow cedars and plant in between the rows of corn a winter cover crop of rye to control soil erosion. We believe that if we could work out a similar technique in the colder parts of Canada, in Ontario, where we could interseed with rye we could pick up a lot of this nitrogen that is not used by the corn crop. If you don't pick up that nitrogen it's going to get through into the groundwater.

3. The carbon-nitrogen ratio of applied wastes could materially influence the release and immobilization of nitrogen.

In a field study involving the use of anaerobically digested sewage sludge for corn production in Ontario, Stewart (8) defined levels of application that could be considered feasible in terms of crop production and minimal contamination by nitrates. The study indicated that yields of corn were not increased significantly by sludge applications in excess of 1.24 cm (0.5 ac-in.). Furthermore, after corn harvest approximately 47 kg NO_3-N/ha due to sludge treatment remained in the 0-90 cm depth of soil and by the following Spring that amount had been reduced to 26 kg NO_3- NO_3-N/ha.

Phosphorus in Soil from Wastes

So much has been written and said about phosphorus in our environment that one hesitates to add to the verbiage. However, a field experiment did provide the opportunity to: (a) establish a relationship between total phosphorus added in the sludge and the amount believed to be plant-available and (b) record the movement and distribution of plant-available phosphorus with depth in the soil profile.

About one percent of the total phosphorus in the anaerobic sludge was found to be in a soluble form. Presumably, the majority of the phosphorus is associated with organics and metals in the sludge. As the soluble phosphates make contact with the soil calcium, it has been reported that a relatively insoluble hydroxyapatite is formed. Various mechanisms and processes have been proposed to account for the uptake of phosphorus from forms of low solubility by plants.

Plant available phosphorus is described as the phosphorus extracted from soil by a 0.05N sodium bicarbonate solution. The total phosphorus added in the sludge for the various treatments is shown in Figure 1. The depth of incorporation was approximately 20 cm. The concentration of plant available phosphorus with depth for the various treatments is diagrammed in Figure 1.

It has been demonstrated many times that when phosphorus fertilizing materials are incorporated with well-drained surface soils, the element is virtually immobilized. A similar situation was found for the plant-available phosphorus, Figure 1; the greatest concentrations of phosphorus were found in the 0 to 20-cm depth. There was no apparent reason for the significant differences in concentration in the 60 to 90-cm depth in view of the lack of significance in the layer immediately above.

When the soil test value for phosphorus is greater than 20 ppm the general recommendation is that a phosphate fertilizer is not required for corn. These data suggest that up to 1100 kg phosphorus per hectare or about 1000 lbs. per acre were required to raise the soil test values above 20 when the phosphorus source was digested sludge.

When forms of soluble phosphorus are added to a soil it is converted to water-insoluble forms. About 10 to 30 percent of the fertilizer phosphorus added to a soil is recovered by a crop in the first year; the remainder is converted to very slowly available compounds of calcium, iron or aluminum. The immobility of soil phosphorus has been demonstrated in many analyses of percolates from soils, tile drainage effluents and samples of groundwater. Phosphorus contamination of streams or surface waters may occur by erosion and run-off.

Now I'm sure that is nothing new to you. I put it in there to draw it to your attention that you as administrators dealing with environmental pollution, you invariably will come up against the instant environmentalist who criticizes you for recommending to farmers that they put on 100 to 200, 150 pounds of phosphate per acre. What your critic doesn't know is that this could be super phosphate having a very low percentage of phosphorus in it. It takes a large percentage of that fertilizer by weight simply to carry the phosphorus. Also the crop is only going to use a small percentage and then they immediately say, "Well the rest washes away doesn't it?" But they fail to realize the enormous fixation and retention capacities of a soil, and it doesn't matter whether that soil is alkaline

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or acid that phosphorus is fixed in an alkaline soil by calcium, magnesium and in an acid soil by aluminum and iron and those types of compounds.

Non-Degradable Materials

In Ontario, the government has attached priority to the development of comprehensive programs designed to augment present pollution abatement and prevention policies. It is hoped that legislation will provide the means of ensuring that all environmental factors are considered in a comprehensive and co-ordinated fashion, including public input, before major projects and technological developments proceed.

Recently, the Ministry of the Environment has placed increasing emphasis on the restorative and preventative aspects of environmental management. The restorative approach complements the abatement process in that it deals with the correction of undesirable conditions, or effects of pollution, in specific areas of the environment rather than the elimination of a specific pollutant (6).

So far in this presentation we have been concerned primarily with biodegradable organic wastes and the principal plant nutrients, nitrogen and phosphorus. Man can easily and unknowingly overload the environment with such wastes. One result of overloading is the changing of the system from aerobic to anaerobic and consequently, induce an entirely different environmental problem.

Non-biodegradable pollutants, such as heavy metals are quite different from degradable in that their effects diminish very slowly with time. There is the danger that their concentrations will increase with time and use and that we will discover the detrimental environmental effects only after it is too late to do anything of a remedial measure. If such a pollutant becomes widely dispersed in the environment, there is virtually no hope of recovery; it is important to minimize their release in the first place.

With these two backgrounds (1) the Ontario government's Green Paper on Environmental Assessment and (2) the knowledge that certain pollutants are persistent, non-degradable, widely dispersed and generally not recoverable the government has established an ad hoc committee for sludge utilization on agricultural lands. While the status reports of the committee are not public information, I am taking the liberty of summarizing my opinions as to where and with what the committee is moving.

1. as the sludge contains plant-available nitrogen, the application rate may be governed by the nitrogen requirement of the crops to which sludge is applied.

2. a potential hazard exists from pathogens and parasites, hence some recommendation may be forthcoming regarding its use on livestock pastures and on land used for the production of human food such as fruit and vegetables.

3. over-loading a soil with phosphorus should be avoided because of hazards to stream and surface water contamination by run-off and erosion.

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4. Recommendations are envisaged which attempt to control the levels of selected heavy metals in the soil; it is also conceivable that some municipal sludges contain concentrations of heavy metals in excess of that acceptable for land disposal. In other words, what we're saying is that some of these sludges are so loaded it's just doubtful whether we're going to put them on land at all. Somebody should go back to industry and tell them to clean up themselves. For instance, we can only look at Guelph's sludge. One hundred parts per million of nickel in the dried material. That's getting to the point where it's almost a good quality ore to mine, to start processing. It contains over 3,000 parts per million of chromium and 200 plus parts per million of cadmium. It's a real hot one.

5. Sludge disposal on acid soils (pH < 6.5) and organic soils may be severely controlled or prohibited. Now if it's an acid soil, it's easy to correct. You can add the calcium carbonate to bring it up or perhaps you could find a sludge that has been treated with calcium hydroxide for the precipitation process.

6. Only digested sludges are to be considered for application on agricultural land.

Ladies and gentlemen thank you very much.

Acknowledgement

The grants in aid of research from the National Research Council of Canada and the Ontario Ministry of the Environment are gratefully acknowledged.

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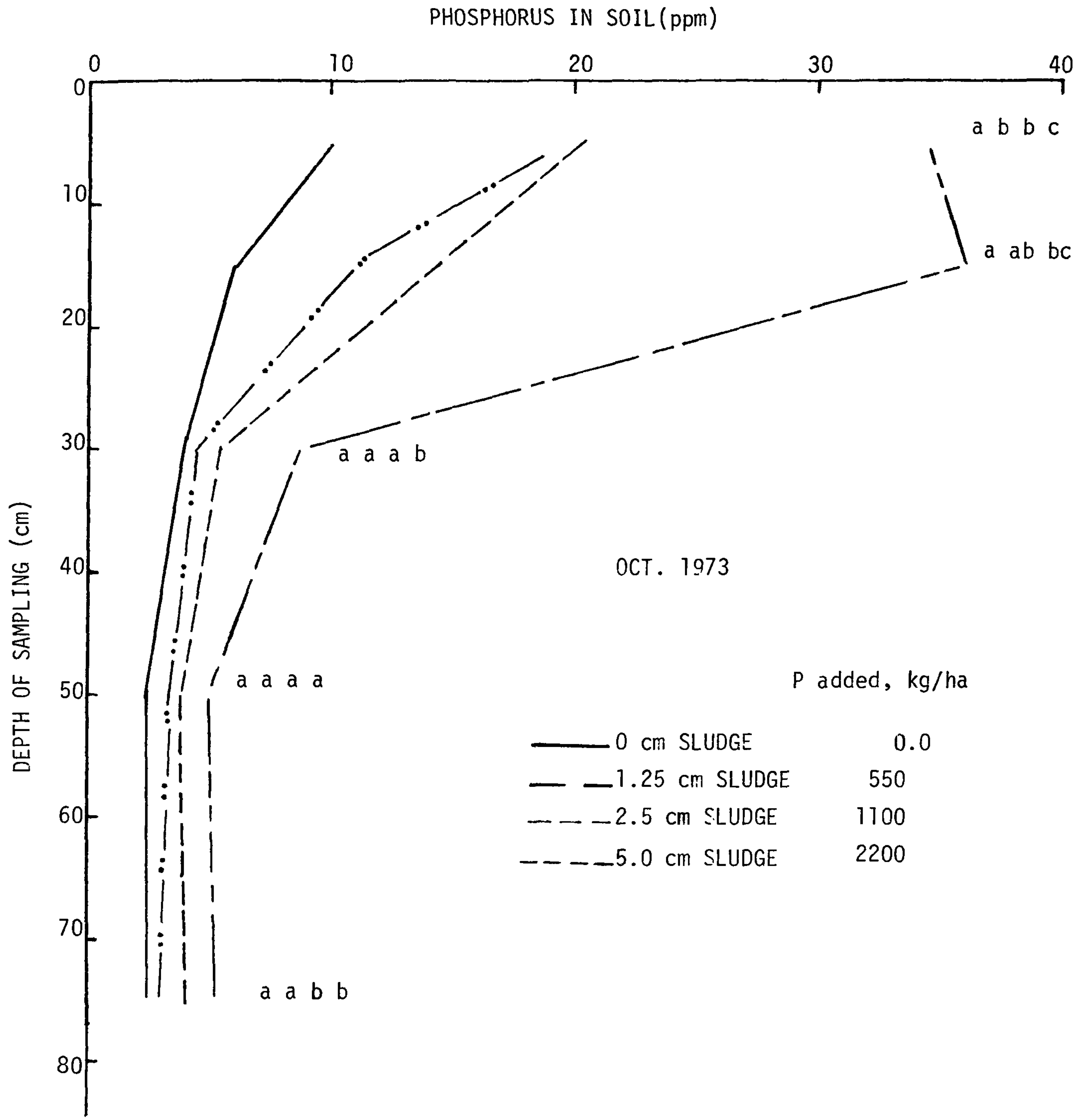

Figure 1

Variations of phosphorus in soil with depth for four rates of sludge application.

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QUESTIONS ON MR. WEBBER'S PRESENTATION

Comment: (Mr. Fedoruk) O.K. We have about one-half hour for questions for Professor Webber.

Question: (Mr. N. Stewart, Department of Agriculture and Forestry. Charlottetown, P.E.I.) Around what date was the rye planted in the experiment - the winter rye?

Answer: (Mr. Webber) It would be about the 15th of September, something like that.

Comment: (Mr. Stewart) The reason I asked was that, at least on PEI, we may have to look at later application dates.

Comment: (Mr. Webber) Well, I think it would be in that order of time, Mr. Stewart, that the rye was planted. The rye is used in several agricultural practices in Ontario particularly in the tobacco growing district. You may have another crop which you could use.

We could have used oats, but they would be killed off. We could have used fall wheat or something like that. I don't know whether those are suitable crops in your area or not.

But the problem is that, sure, we pick up a lot of nitrogen with this winter seeded, inter-seeded, crop, but what are you going to do with the crop? If you don't get it out of there, either by mechanical harvesting or grazing, you're leaving the nitrogen there, you're not gaining, you're just going in the proverbial circle.

Question: (Miss L. Thomas, Nova Scotia, Department of the Environment, Halifax, N.S.) Professor Webber, were all the soil profiles for unsaturated soil and would you have any information on what the nitrate concentrations were once it reached the groundwater?

Answer: (Mr. Webber) This was naturally, well-drained soil. We did not get anywhere near the groundwater on this study at all. We're talking about unsaturated flow of nitrates in soils. These values are taken at times when the soil moisture is generally at or drier than field capacity. Only in an odd sampling was the soil moisture slightly above field capacity. We were not dealing with saturated soils whatsoever nor do we know what the actual content of the groundwater was. We would have to look at some of the lysimeter data for that.

Comment: (Mr. A. Hamming, President, Federation of Agriculture, PEI) I want to impress on you the very great need for more communication. I think it is most important to relate soil management to a knowledge of soil chemistry, and we should be doing everything we can to educate our next generation of farmers. Right now we don't seem to know the basis at all. And we're too busy looking after the problems that we do have. So I think we should press to get every bit of information we can get and to work together with departments of environment and so on.

Comment: (Mr. Fedoruk) You have a very good point there and basically the name of the game is communication. If one party doesn't understand it makes it difficult. You have a very good point.

Comment: (Mr. Webber) I can only agree with you, Mr. Chairman, for the excellent way our friend put it here and we must agree with you. sir. I'm a long way from home, and maybe I can tell you this, it may not get back there before I get there, that we have a proposal in Ontario for a housing development in the recreational part of Ontario, as we say. There is no opportunity for treatment of the sewage from the private homes, so the company approached the government to look at the possibility of disposing of the sewage from these cottages and condominiums on land, and the developer got hold of us. We made our proposal as to what we would like to do to investigate the problem. It then came back from a government official who said that Mr. Webber and his crew must provide the government of Ontario with statistical evidence showing the degree of adsorption by that soil of chlorides, of nitrates, and other anions. Now then, what can you do with that sir, when an official of the government is so convinced that there is a significant adsorption of these anions, of chlorides, nitrates, and sulphates by the soil. You might as well forget the plan because if that is going to be his attitude, that we've got to show there is adsorption of these anions then we might as well forget it.

Question: (Mr. V. Kresta, New Brunswick Department of the Environment, Fredericton, N.B.) Generally, I agree with you that only the digested sewage sludge should be applied to a field. However, too many sewage treatment plants simply do not have this stage. Could you please summarize the main reasons against applying non-digested sewage sludge to crops?

Answer: (Mr. Webber) From my experience in Ontario, I believe that we are going to control, rather rigidly, the application of undigested sewage waste to soil. Now, upon saying that I have to immediately back track and say we do permit, with permits, the application of, what we call pump-outs from septic tanks. We do permit that to be spread on land, under permit, under rigid control. It is partially digested.

On the other hand, sir, there are countries of this world where many, many millions of gallons of raw sludge is spread directly on the land. Back in the early '70's a publication from Israel said that 20% of the sewage from the population of Israel is spread directly on the land.

We had a chap in the office last week who has just returned from a several weeks' tour in China. In the city of Peking, in the morning, you would see hundreds of these honey-wagons coming out of the city of Peking going out to the farm to dispose of the sludge that way.

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Now, in our opinion the hazards with using raw sludge are mostly health standards, the transmission of disease and that type of thing. It is correct, we believe, that a partial treatment of the sludges will pretty well reduce the coliform bacteria and we have used the coliform bacteria as an indicator of the degree of success of treating the sludge. But that is not necessarily so. Coliforms occur everywhere, they occur naturally. Not only do they originate with man but they originate with animals. If you get a positive test from a field study for coliforms you cannot say just from whence it came. The absence of coliforms in treated wastes whether they be sludges or wastewaters or whatever, the absence of coliforms does not say that the viral pathogens and the parasites and all this stuff are also absent. You can treat to remove those. It does not say that you will have a zero test for viral pathogens. I think that is the principal reason why we are just a little hesitant about using raw undigested sludges. Of course, there is the aesthetic value as well.

Question: (Mr. Kresta) In chicken manure there are, I understand, a lot of coliforms. Yet chicken manure is widely accepted as a fertilizer. Can you relate this to the use of undigested sewage sludge?

Answer: (Mr. Webber) What you say is correct and also it does contain a lot of coliforms. Your system can adjust to some coliforms that's true, but it only takes one viral pathogen and believe me, I speak from experience on that. It only takes one and what the probability of it is I don't know. It's a way out. That's what scares me, the pathogens, of which we know so very little. It's just difficult to get people to work in a lab with live, active polio virus, it's just too frightening.

I suspect that with the livestock manures that once they are incorporated in the soil there is a reasonable degree of safety. Secondly, if the waste is left exposed to the atmosphere the drying action and the ultraviolet from the sunlight is a pretty good sterilum and may reduce it that way.

Question: (Mr. W. Phillips, Environmental Control Commission, Charlottetown, PEI) Mr. Webber, there is one small point. Getting back to the request for absorption data by the Ontario official, was that out of context with respect to an environmental impact study?

Answer: (Mr. Webber) Well, I did not take my statement out of context. Let's get that straight. Secondly, they are all uptight on this environmental assessment business. A little more on the background situation: it is a recreational lake in Muskoka in the Precambrian district. The proposed development borders a rather lovely, large recreational lake. The soils are shallow and thin and I think we are going to have difficulty. But be that as it may, I don't know what the Department wants when they ask for a statistical interpretation of differences in these soils for anion exchange and anion absorptions. I don't know how you show it. We say generally it doesn't exist, for one of the better tracers in groundwater studies is the chloride ion. It's one of the better ones we have.

Question: (Unidentified) Can you make a few comments on spraying sludge in forest lands?

Answer: (Mr. Webber) No, sir, I don't know anything about it. There is an excellent publication from Penn. State where the boys down there have spread sewage effluent from the University City Complex. They have spread it on forested land for several years and about two years ago they had a several days' symposium on this. One of the features of that symposium was the use of forest covered land for the disposal of these wastes. I have no knowledge in that area whatsoever.

CURRENT MANURE MANAGEMENT PRACTICES AND THE STATUS OF PROCESSING *

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Introductory Comments: (Mr. Fedoruk) Next on the program we're going to have Mr. Bob Hore talking on animal waste treatment and disposal. Bob gradulated from the Ontario Agriculture College in 1949 and received his MS degree from Michigan State University in 1953. From graduation until the summer of '68 he worked for the Ontario Agricultural College in extension, teaching and research capacities in the field of water resources with particular emphasis, since 1963, on the problem of controlling pollution from animal manure. In 1968 he joined the Engineering Research Service of the Canada Department of Agriculture in Ottawa as a development and advisory engineer, water resources, where continued emphasis has been placed on development research for the management of animal manure.

Mr. Hore......Thank you, Mr. Chairman. I want to talk about current animal waste management practices. More specifically, I would like to avoid, if possible, the term "animal waste". I refer to it as it is, manure.

Statistics show clearly that the number of large-scale animal production enterprises is increasing on the average, but there are still a great number of small to medium sized enterprises. These latter farms do not draw much attention to society because, individually, relatively small volumes of manure are produced, and they do not appear to be a gross pollutional threat to the environment. The hazards are small where reasonable control of manure is practiced, but with mismanagement, local problems can be created such as high nitrate levels in water supplies near manure piles or direct manure run-off from feed lots into small streams.

It is really only within the past decade that the major changes to large-scale confinement of animals have occurred and that their manure management problems have become apparent. Today, many operators with these new or expanded facilities are aware of the amount of manure that is produced and that requires control. Planning and construction for some reasonable management of manure are being incorporated in the overall production unit from the beginning.

This principle is being followed in new plans prepared through the Canada Plan Service (CPS), formerly known as the Canada Farm Building Plan Service (CFBPS). Although there is no assurance that all components are constructed according to these plans, some of the best recommended practices based on current technology are becoming available for implementation. At the same

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* *Engineering Research Service Contribution No. 501*

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time, several of the provinces have publications outlining recommended practices, and a Canada Animal Waste Management Guide under the authority of the Canada Committee on Agricultural Engineering has been available since December, 1972.

The awareness of the need for manure management and the action that is being taken has undoubtedly been influenced by the producer's recognition of his personal responsibility as a citizen to control environmental pollution from his operation, or by the requirements of legislation. All provinces have legislation covering pollution or nuisance that may endanger public health. In 1971, Saskatchewan enacted legislation directed specifically to the livestock producer, "The Pollution (By Livestock) Control Act, 1971".

The effects of operator awareness, legislation and the availability of recommendations and plans for reasonable manure management systems can be seen, but there is still need for much field research, development and monitoring to provide data required for design, for more economical practices, and for modifications to present recommended practice for the many and varied animal production conditions across Canada. Much improvement in existing practices where little pollution control is being exercised can be expected as the need for control becomes more widely known and accepted, and existing technology is applied.

RECOMMENDED MANAGEMENT PRINCIPLES

Recycling of manure on the land for crop utilization is, and likely will be for some time, a basic concept of present manure management practices, and regardless of the amount or type of processing that may become economical to solve specific management problems, there will always be some product or residue from the system to be returned to the land.

Considering the current status of technology and economic conditions in the animal production industry, the following manure management principles are generally accepted:

1. Access to sufficient land for crop utilization of manure and limiting the rate and time of application to avoid water pollution.

2. Separation between confined animals and neighbours to avoid nuisance complaints by allowing dilution of unavoidable barn and feedlot odors and flies and dissipation of noise.

3. For housed animals, frequent manure removal from the barn into separate and undisturbed storage to minimize odor levels in the barn and avoid animal and human exposure to gas hazards particularly from stored liquid manure.

4. Sufficient manure-tight storage capacity to control surface water and groundwater pollution and avoid winter land application of manure.

5. Rapid soil cover of manure to control odors during land spreading and control manure washing from fields when surface run-off occurs.

Most recommended practices are based on meeting the requirements of these principles.

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MANURE MANAGEMENT SYSTEMS

It is not possible to have a singular system for all species of livestock and for all suitable alternate methods of animal management even though some equipment components of the systems are common. For example, (1) the differences in climatic factors, particularly rainfall, snowfall and temperature across Canada, (2) the textural nature and nutritional value of feed, (3) the choice to use or not use bedding and if used, the amount and type, (4) the amount of dilution water added to liquid manure, (5) the method of storage, (6) the amount of weather protection or induced drying given to stored manure, all affect the manure consistency and other characteristics and hence its method of management. However, in most manure management systems for confinement operations, the following functional sequence does apply: collect (temporarily store), transfer, store, remove, transport, apply to land.

Because the methods of animal management and the properties of manure are not the same for all animals, suitable handling systems have been developed separately for each kind of animal. Recommended systems for beef cattle, dairy cattle, swine and poultry are outlined in specific detail in the Canada Animal Waste Management Guide, and where necessary, the effect of climatic differences across Canada have been taken into account. Some of the several alternate systems shown for each kind of animal differ simply in the provision of more or less automation. Other alternatives are specifically tied to given methods of animal management and particularly to the way fresh manure is modified in its consistency (its resistance to movement or separation). The consistency of fresh manure is always changed, more or less, somewhere within the handling system.

Although other factors are involved, the moisture content of manure has an important effect on its consistency and hence on the selection of handling equipment and facilities. Based on consistency, manure is handled generally as either a liquid, solid or semisolid. For example, where animal management practices exclude or restrict the use of bedding, liquid manure with a thin consistency is produced by adding water (intentionally, or from leaky waterers). Some liquefaction also takes place when liquid manure is stored anaerobically. At 85% moisture content or greater, liquid manure will flow by gravity from deep horizontal gutters, and, at 90% or greater, it can be readily pumped. On the other hand, where ample bedding is used or manure is subjected to natural or induced air drying, solid manure is usually produced with a stiff, nonflowing consistency that is handled by an established line of solid manure handling equipment. Manure with 8% bedding or greater will have this consistency. There are, however, existing management practices where the amount of bedding or drying is limited, and semisolid manure is produced with a thick consistency that may flow slowly or hardly at all. For instance, when about 2% long straw bedding is added to fresh dairy cattle manure, this mixture will likely flow slowly, whereas very little flow will likely occur with additions of about 4%. Some modifications to conventional solid manure facilities and equipment are required to handle semisolid manure.

In each of the alternate systems outlined in the Guide, manure consistency is taken into account by specifying the type of handling facilities and equipment required. Table 1 is an example of the alternate manure handling systems for swine. From left to right, this table shows the "type of animal management" that may be chosen by the animal producers, the "type of manure"

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TABLE 1 MANURE HANDLING SYSTEMS FOR SWINE

Type of animal management	Type of manure	Collection and transfer	Storage	Removal and transport to land	Comments
Bedded pens (see CPS plans) 3017 3024 3025 3028 3032 3036 3426	Solid manure	Shallow gutter, gutter cleaner to elevator	Stack on curbed slab (see CPS plan 2372)	Tractor loader to spreader to land	Only practical where bedding is abundant and inexpensive
	Manure stack runoff	Surface drains and/or sewer	Retain within storage or drain to detention tank or earthen basin	Vacuum tanker to land	
Little or no bedding (see CPS plans) 3017 3021 3022 3023 3024 3025 3028 3032 3035 3036	Liquid manure	Hand scrape to shallow gutter, shovel or gutter cleaner to opening into storage OR Hand scrape to deep narrow gutter, gravity flow from gutter through valve and gas trap into storage OR Partially slotted floor, through slots to either (i) trench below, gravity flow from trench through flapgate and gas trap into storage, or (ii) trench below, removal from trench and transfer by vacuum tanker to distant storage, or (iii) continuous loop trench below for oxidation ditch Effluent overflow into storage (see part G, sect 2.1)	If storage site below level of collection facilities, gravity flow to large tank (see CPS plans 3252 and 3253) or earthen storage (see CPS plan 2371) If storage site above level of collection facilities, gravity flow to short-term holding tank, pump to large above-ground circular tank (see CPS plan 3250)	Pump-agitator to tanker to land OR Vacuum tanker to land	To exclude long-term storage gases from barn, provide a gas trap where manure enters storage, OR provide a continuous-running fan exhausting from storage This fan should be selected to give the first stage ventilation rate required by the livestock
Open paved runs and covered bedded area (optional for breeding herds)	Solid manure	Hand scrape to open paved run, tractor scrape to storage	Stack on curbed slab	Tractor loader to spreader to land	
	Runoff from paved runs and manure stack	Surface drains and/or sewer	Retain within storage or drain to detention tank or earthen basin	Vacuum tanker to land	

that results from the chosen type of management, and the components that can be used for each functional part of the handling system.

PARTS OF THE SYSTEM

Collection and Transfer

Odor production in confinement barns can be minimized when collection facilities are small and manure is transferred at frequent intervals to separate storage. The in-barn environment is therefore subjected only to the unavoidable odors from animals and fresh manure. Large collection facilities for liquid manure actually become anaerobic manure storages. Where collection and storage are combined, special precautions such as extra ventilation are necessary to minimize risks from hazardous gases released during agitation. Figure 1 is an example of three methods to collect and transfer swine manure.

Storage

Storage structures are required to hold manure and feedlot run-off between periods of land application. Although different farms have different storage needs, there are several general points in the Guide related to storage location, size, construction and operation that should be observed. Specific requirements differ for solid, semisolid and liquid manure. Detailed plans for several types of storages, prepared by the Canada Plan Service (CPS), are available through the extension engineers at provincial departments of agriculture.

Figure 2 is a plan for construction of a below-ground rectangular concrete tank for storage of liquid manure where a roof or cover is required to control odor and exclude snow and rain. A clear-span roof made with wood trusses and sheet metal roofing prevents accidents and keeps out snow and rain. The roof cover seems to reduce odor problems as well, and this will be an important consideration if there is a house or any neighbours downwind.

Figure 3 is a plan for a reinforced concrete tank to safely store liquid manure until it can be spread on cropland and utilized as valuable fertilizer by growing crops. This plan shows an open top, with a steel safety railing. If a roof or cover is required for heavy rainfall, odor control, or to satisfy local regulations, a rectangular tank is easier to cover. See plan 3253 (Figure 2) for a roofed rectangular tank.

Figure 4 is a plan for an open-top reinforced concrete silo designed to safely store liquid manure. Above-ground storage costs more than gravity-filled below-ground storage (as in Plan 3252, Figure 3), but there may be no alternative for flat land, or where the groundwater table frequently rises close to the surface. For storage above ground, pumping is required to elevate and agitate the liquid manure, and the circular silo shape is the most economical form to hold the liquid manure pressure.

Figure 5 is a plan for a liquid manure storage pond which can be built at the least possible cost. This type of storage is best suited to regions of low to moderate precipitation and where an impervious clay sub-soil can be packed to make manure-tight banks and floor. Do not use this type of manure storage over sand, gravel, or fractured bedrock since leakage could cause pollution of underground water supplies.

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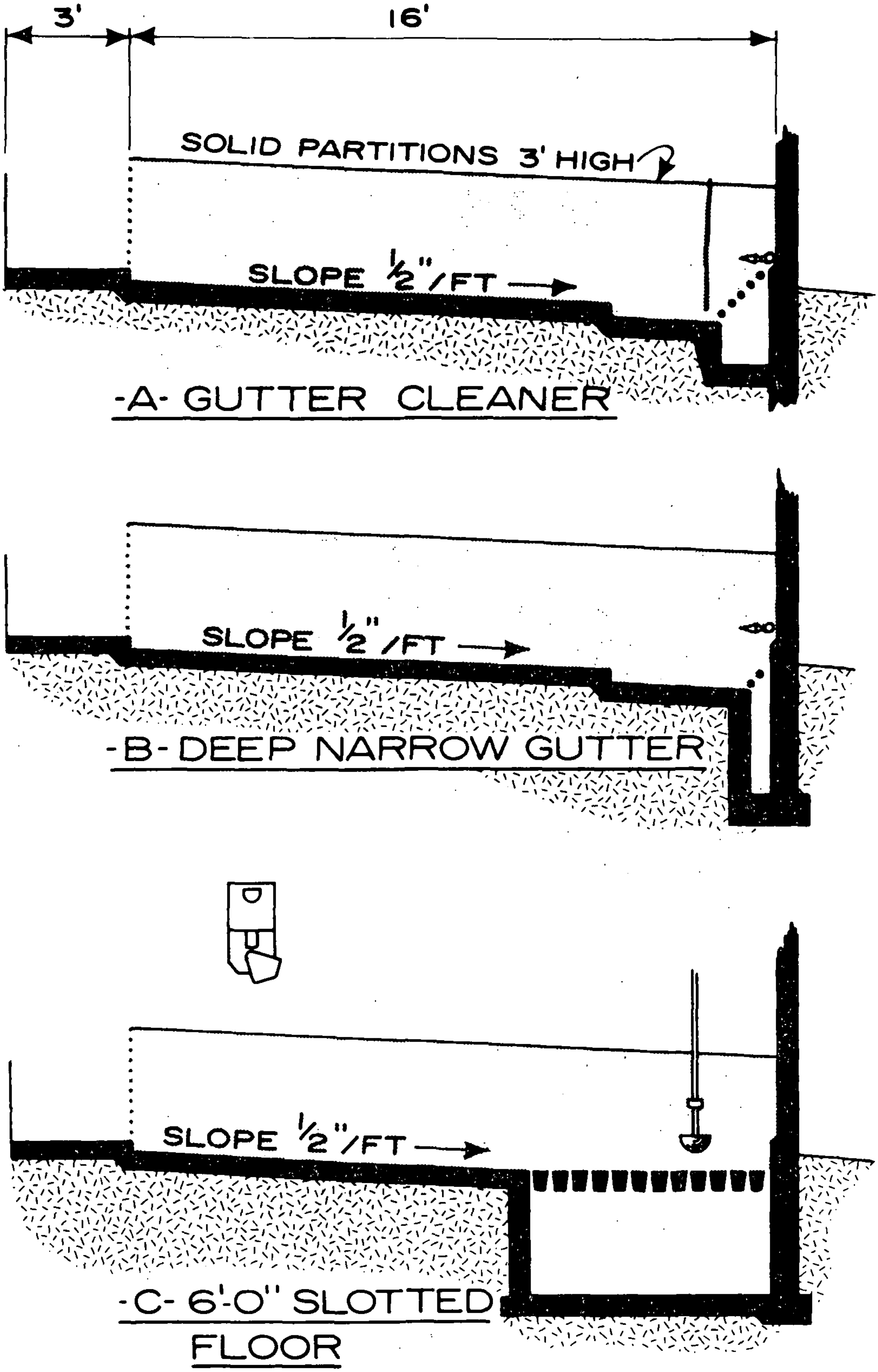

Figure 1. Three Methods of Collecting and Transferring Swine Manure.

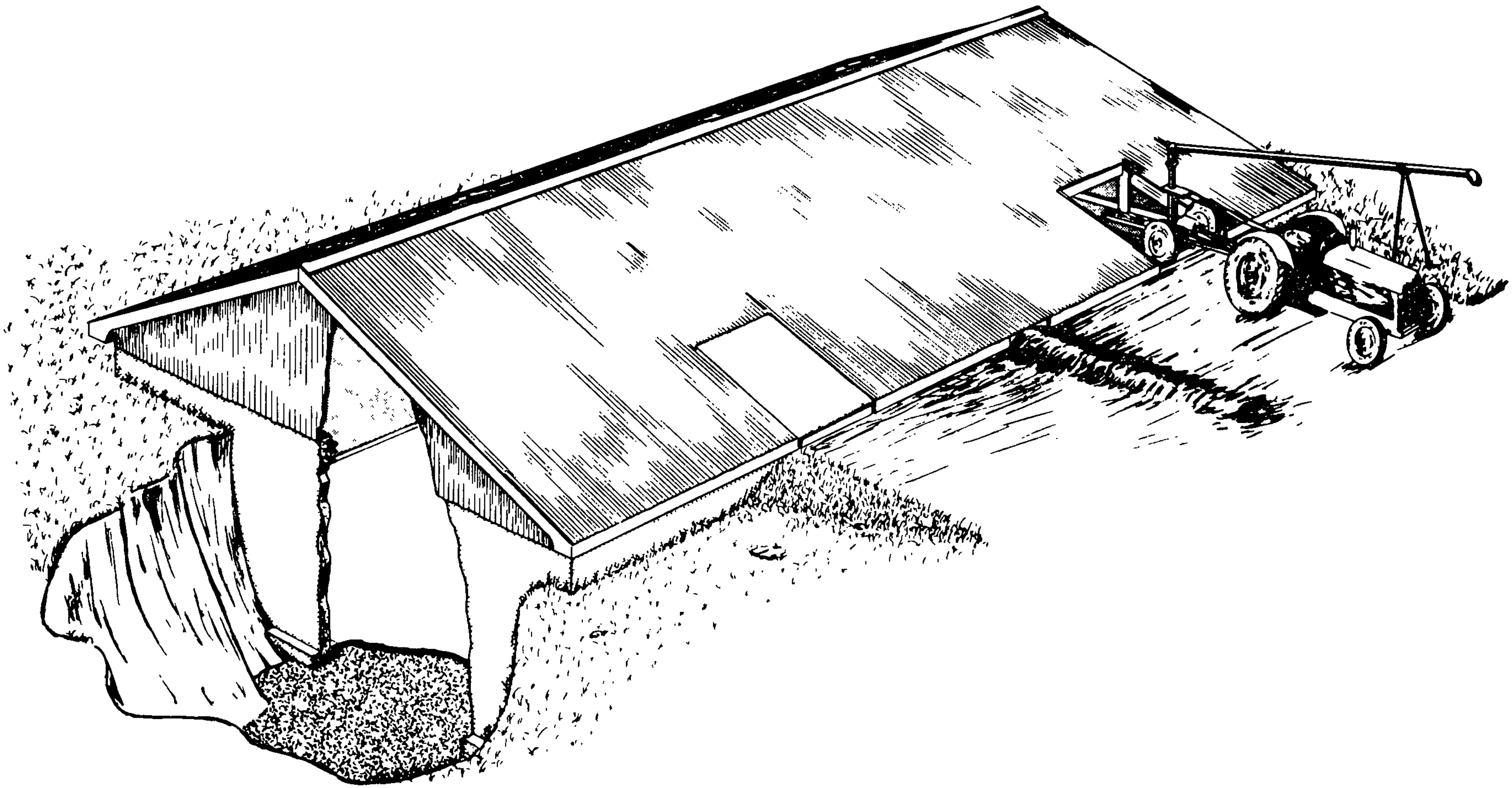

Figure 2 Rectangular Roofed Manure Tank (CPS Plan 3253)

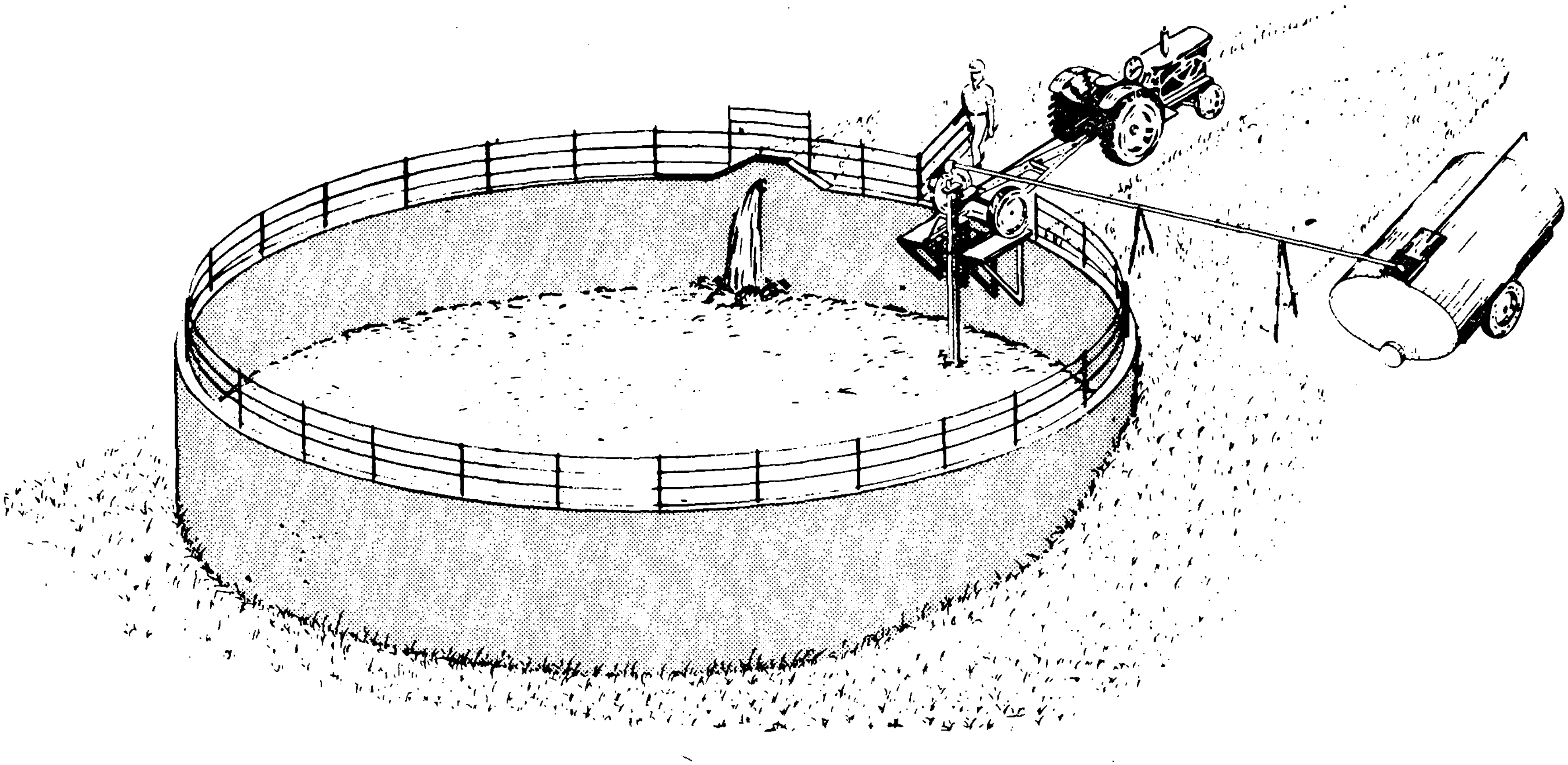

Figure 3. Below-ground Open Circular Manure Tank (CPS Plan 3250)

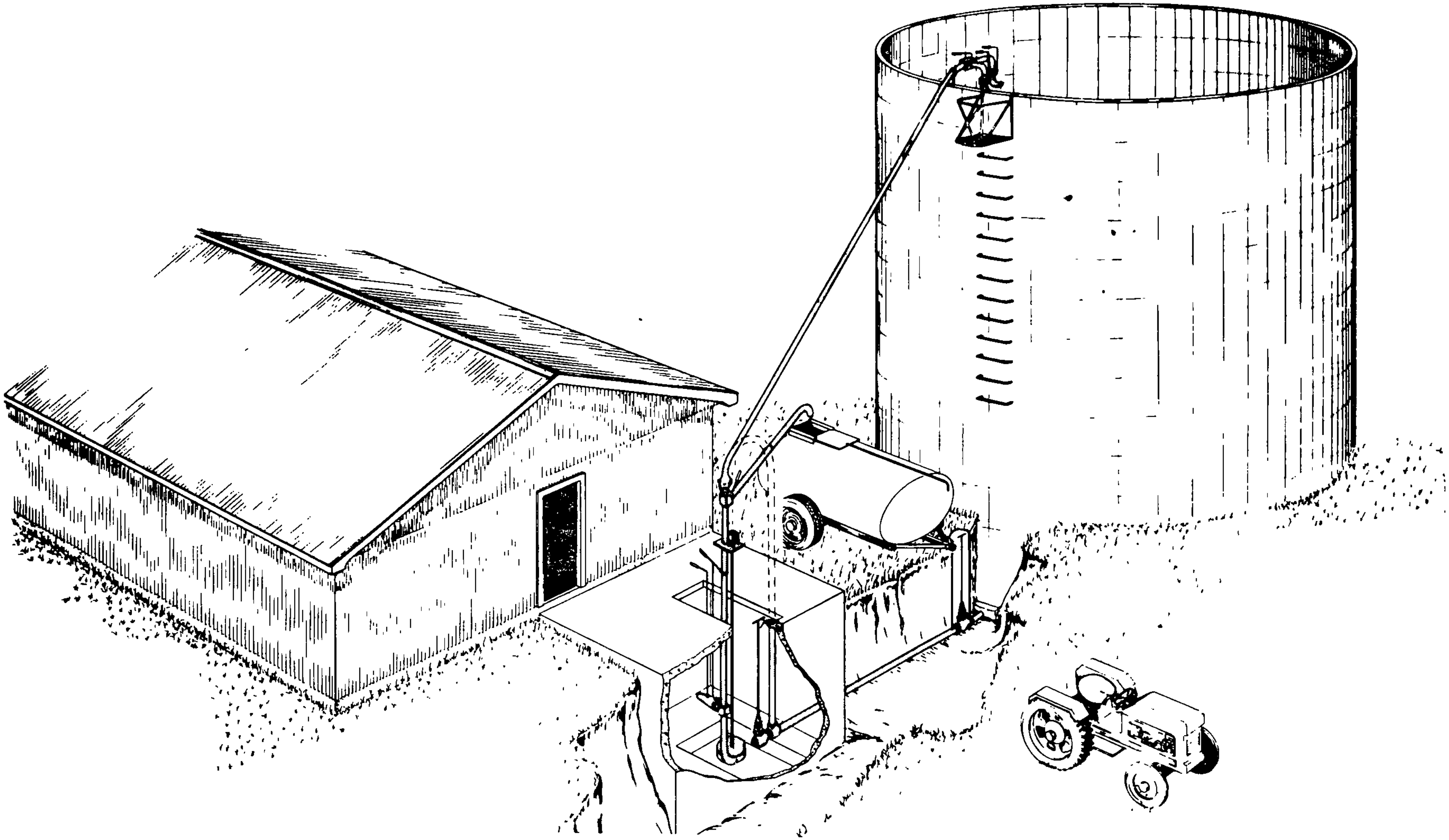

Figure 4. Above-ground Liquid Manure Silo-Tractor pto Pump System (CPS Plan 3250)

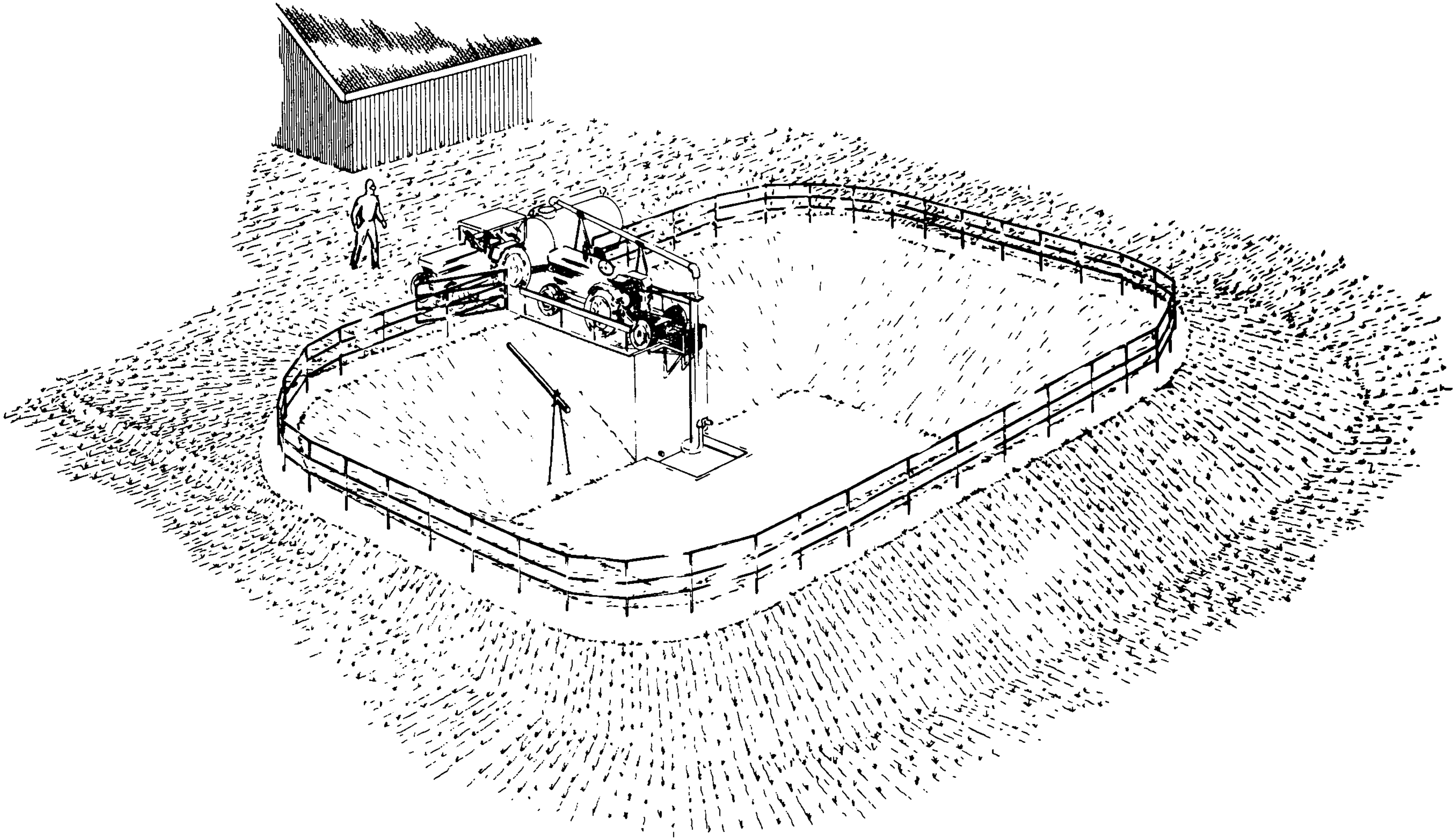

Figure 5 Clay-lined Manure Storage Pond with Pumping Dock (CPS Plan 2371)

Figure 6 is a plan of an open circular storage with reinforced concrete walls. It is best suited for storage of semi-solid manure with little bedding added, such as manure from dairy free-stall barns. The walls and the sloping tractor entrance ramp contain liquids as well as solids to control pollution of nearby streams and other water supplies. The tractor entrance ramp is for loading, hauling, and spreading operations with a tractor front-end scoop loader and manure spreaders.

Figure 7 is a plan of an open rectangular concrete slab with a low curb and high earth bank to contain liquids as well as solids. To control pollution of nearby streams and water supplies, this storage should be built only where the sub-soil contains enough clay to make water-tight banks. This storage is best suited for semi-solid manure with little bedding added, such as manure from dairy free-stall barns. An entrance ramp gives access for a tractor front-end scoop loader and manure spreaders for loading, hauling and spreading operations. Stop-logs may be placed across the entrance ramp when required to contain manure liquids.

Figure 8 is a plan for a rectangular manure storage with reinforced concrete walls 8 ft. high and a roof to keep out rain. This type is best suited for semi-solid manure with little bedding added, such as manure from dairy free-stall barns. The walls and the sloping tractor entrance ramp hold liquids as well as solids, to control pollution of nearby streams and other water supplies.

Figure 9 shows a rectangular slab for swinging manure stackers, or a square slab for fixed stackers. Manure from typical livestock operations where considerable bedding is added (dairy tie stalls, for example) can be piled up with a mechanical stacker. With this "solid" manure, a low concrete curb around a storage slab is adequate to control pollution of nearby streams and water supplies. The manure will form into a roughly conical pile and the curbed corners of the slab provide economical storage for the rainfall, snowmelt and liquids draining from the stack.

Storage capacity requirements for the run-off from open feedlots and manure storages have received attention only recently. Therefore, it is not possible to make specific recommendations for the broad range of Canadian conditions. However, it is generally accepted that the required storage capacity is dependent on hydrologic factors which affect the run-off from the feedlot or manure storage area.

Removal, transport and land incorporation

Suitable conventional handling equipment is available to remove, transport and spread solid and liquid manure on the land. Special, but available equipment and facilities are required to handle semisolid manure and include a buck-wall for a scoop loader to work against and either a box spreader with end-gate or an open-top, flail-type tank spreader.

To minimize the odor nuisance when spreading manure on land, spread it downwind from neighbours and during periods of the day when air movement favours odor dispersal. Covering manure by plowing or disking as soon as possible after spreading greatly reduces odor and also reduces the possibility of manure washing from fields during surface run-off.

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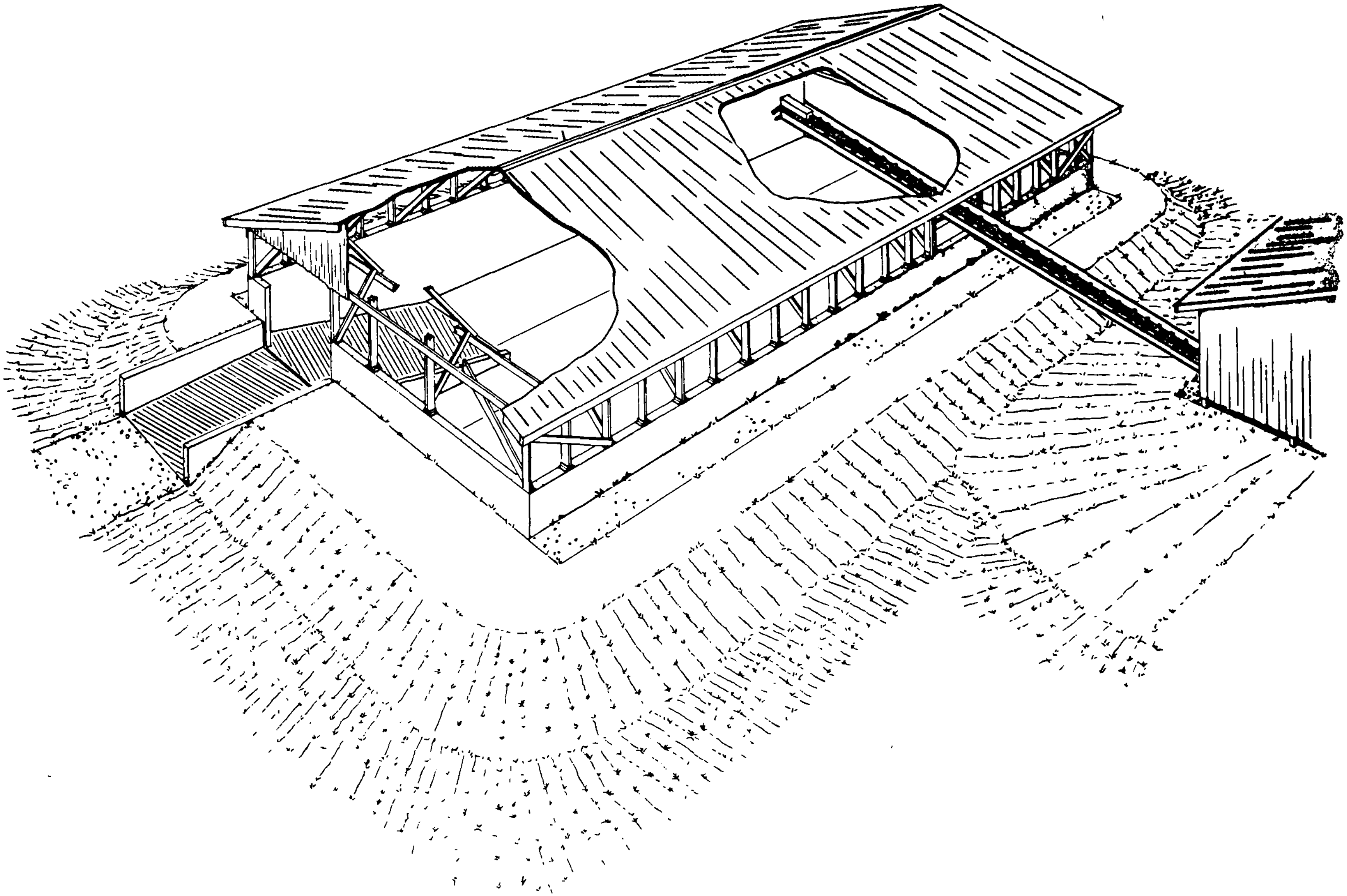

Figure 8 Rectangular Roofed Storage for Semi-solid Manure (CPS Plan 2377)

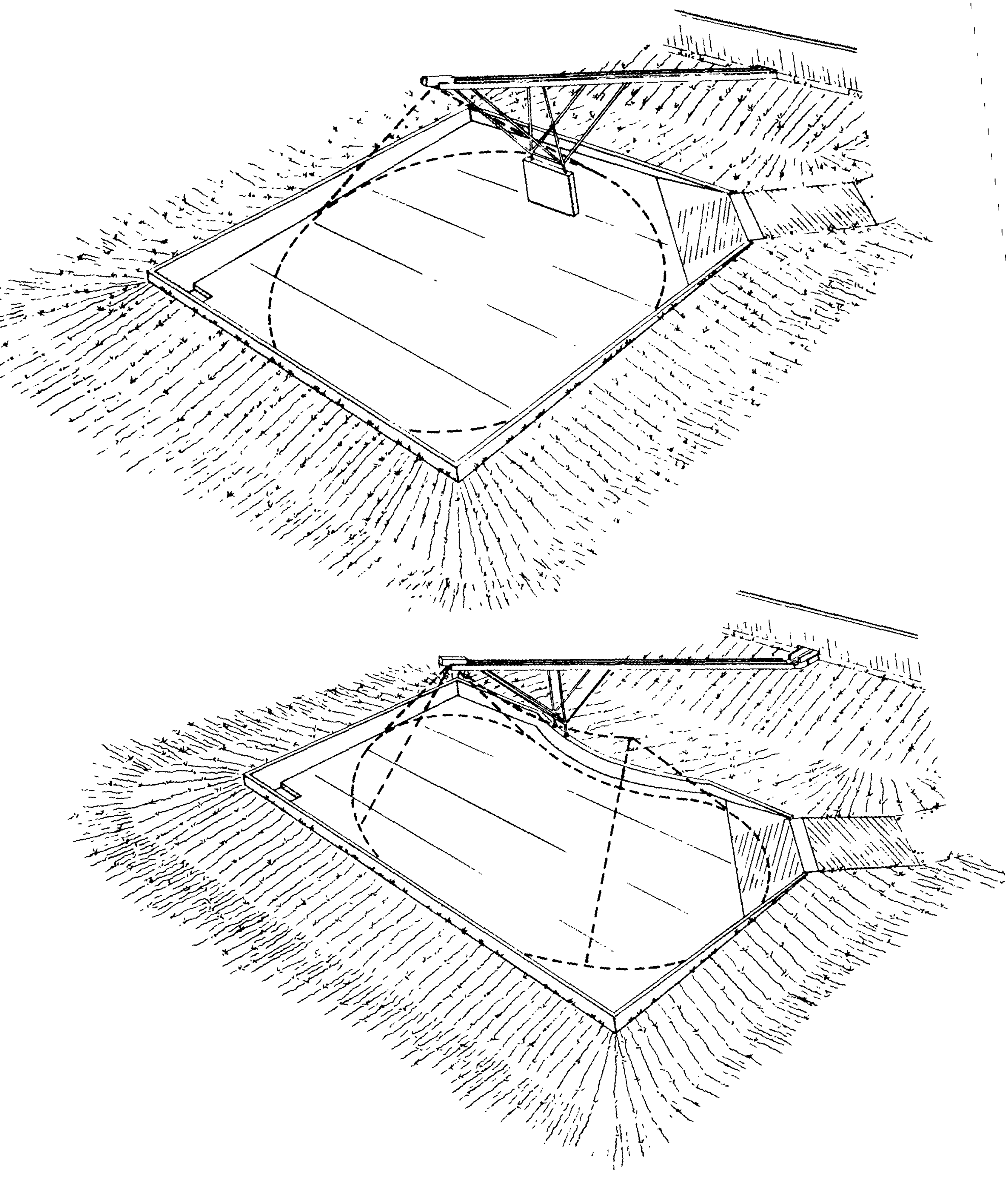

Figure 9 Curbed Storage Slab for Stacked Manure (CPS Plan 2372)

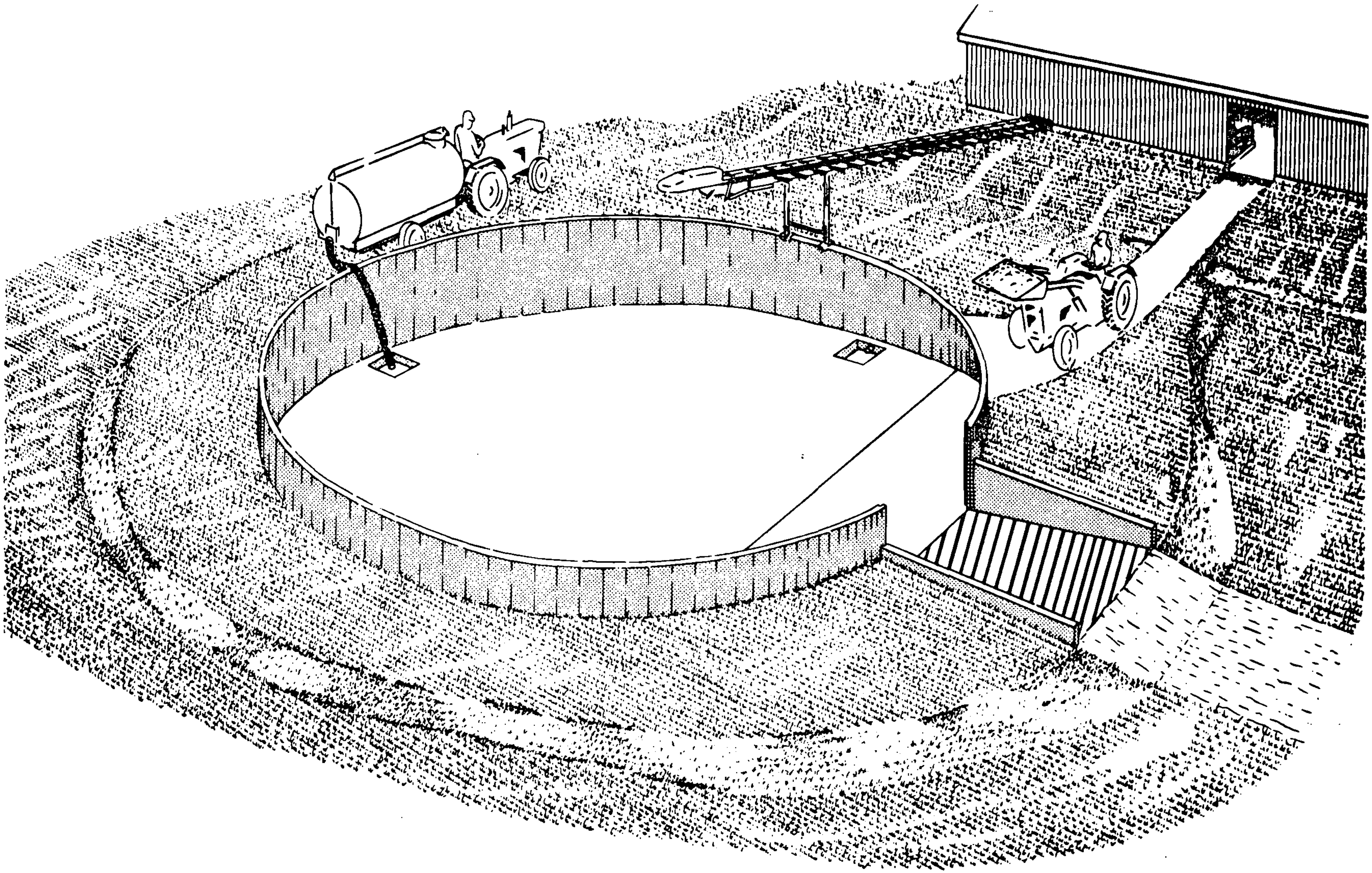

Figure 6. Open Circular Manure Storage With Tractor Access (CPS Plan 2275)

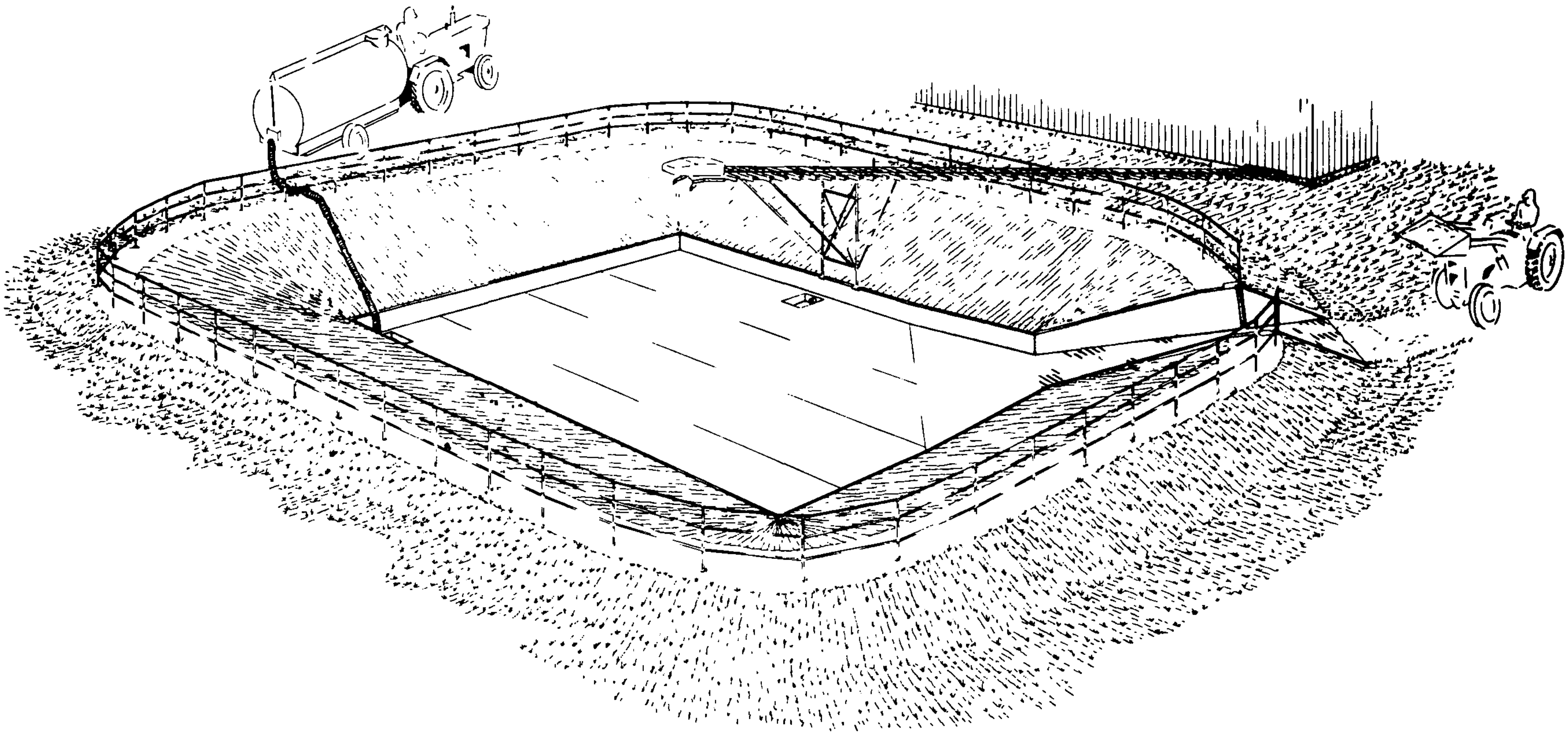

Figure 7 Curbed Slab Manure Storage with Earth Banks (CPS Plan 2376)

Although not widely practiced, two methods for incorporating liquid manure into the land have been developed. In the plow-down method, inexpensive hoods are fitted to tanker outlets to divert manure downward into a 4-foot swath; a second tractor with wheels set wide apart and pulling a plow slightly wider than the manure swath, follows the tankers and covers the manure swath within seconds. This method is not efficient for most farm operations with only one tanker, but it can be improved by pooling equipment with other neighbours. Also, concentrating manure in a relatively narrow swath results in application rates higher than those with conventional spreading equipment. However, by reducing the tanker outlet size to 3 inches in diameter, reducing the discharge pressure at the outlet, and travelling at a forward speed of 3 to 4 miles per hour, the application rate can be kept below 30 to 35 tons of liquid manure per acre.

The second method for land incorporation of liquid manure is the soil injection method. This method holds the greatest potential for odor control, for prolonging the time period of application in the Spring (such as interrow application in corn), for incorporating manure into hay and pasture without completely destroying the crop, and for achieving an acceptable rate of application. Soil injectors that are presently available (about eight) lead liquid manure under pressure from the tanker through tubes located behind deep cultivator teeth. From observations to date, some refinements are still required to avoid trash buildup ahead of the injector unit, to ensure adequate coverage behind the unit, and to make them suitable for row-crop application under a wide range of soil conditions. For the corn producer, injection could extend the time of manure application by a few weeks during the critical work period in the Spring; for the hay and pasture producer, manure could be incorporated without plowing and unnecessary loss of crop. Application rates below 40 tons of liquid manure can readily be achieved.

Existing rapid cover plow-down and soil injection equipment is designed for liquid manure and is not suitable for producers that have an odor problem with solid and semisolid manure.

PROCESSING OF ANIMAL MANURE

Processing of manure to reduce some of its objectionable characteristics is not yet widely done. However, the following processing systems, which are either being used, researched or considered for manure, are discussed to indicate their present status.

Anaerobic Process

Anaerobic decomposition takes place in water-saturated organic wastes when dissolved or free oxygen is not present. The end products are new bacterial cells, inert solids, water and gases such as carbon dioxide, methane, hydrogen sulfide, organic acids, and mercaptans. The latter three gases are odorous, and methane when mixed with air can be explosive. Because of the hazardous and odorous gases produced, the anaerobic process for animal wastes will likely have limited use in Canada.

The anaerobic lagoon and digester are two systems of current interest for the anaerobic processing of animal wastes.

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Anaerobic lagoon

During the Summer months, anaerobic lagoons provide a suitable environment for the biological decomposition of manure; little activity takes place in the Winter. However, because the accompanying odors are a nuisance, these structures have not been accepted generally except in isolated locations away from neighbours.

Most anaerobic lagoons are essentially out-of-door storages where manure is diluted by rain and melted snow and some breakdown of material occurs. The effluent from overflowing anaerobic lagoons is not acceptable in quality by most water authorities for discharge into a natural body of water. Storing the effluent and applying it to cropland is a suitable method of handling this problem.

Additional recommendations for loading rates and lagoon construction are contained in Part 2 of the Canadian Code for Farm Buildings*.

Anaerobic digester

Anaerobic digesters are widely used for the processing of dilute organic sludge removed from municipal and industrial sewage. Most digesters are circular, air-tight structures 20 to 35 feet deep and are equipped with external mixing devices and heat exchangers to maintain a sludge temperature between 90 and 95°F. Sludge is added once a day or oftener. Once the digestion process is established, sufficient methane gas is usually produced to heat the digesting sludge and provide excess fuel for other uses. After World War II, a limited number of digesters were built in Europe, Asia and Africa to use manure and crop wastes for the production of methane gas as a source of power on farms.

These experiences have raised some recent interest in the possible use of digesters to process manure. No known digesters are used commercially for this purpose in Canada, but one pilot-plant project is in progress and some other proposed studies will likely be conducted. Although there are advantages to be gained from manure digesters, such as the production of a stable end product and a valuable gaseous fuel, several limitations require careful consideration. These limitations include a high capital cost for proper structures, equipment and gas control devices (about $20,000 for 100 dairy cows), continual care to avoid explosions, and at least daily feeding of diluted manure to the digester. Continual supervision is necessary and various remedial measures must be taken when the process becomes 'upset' since it is extremely sensitive to environmental conditions such as pH and temperature. Also, although some volume reduction is achieved, considerable digested material will require storage and application to cropland. Because of these limitations, digesters for manure are not likely to be used widely in the near future.

Manitoba has a pilot plant digester under study at the present time. They've been through the lab, they've been through the bench scale and they've come up through the pilot plant stage of development. They are presently producing methane gas and looking at its possible application on the farm. The most advanced study is at the Rowett Institute in Aberdeen. They have a 5,000 gallon digester outdoors. They wanted to automate

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* Issued by the Associate Committee on the National Building Code, National Research Council of Canada, Ottawa.

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it as much as possible because farmers are out to farm, to produce, not to be running anaerobic digesters. The digester, is a single stage digester. The gases are taken off into a gas holder which is nothing more than a gasometer.

Aerobic Process

Aerobic decomposition occurs when a dilute mixture of organic wastes and water is supplied with dissolved oxygen. Under these conditions, aerobic bacteria use the organic matter as a food source in biochemical and oxidation reactions to produce new bacterial cells, carbon dioxide and water as the primary end products. In practical systems, all the organic matter will not be decomposed aerobically and accumulation of these stable solids along with fixed solids will result.

The main benefits of aerobic decomposition are that the entire process is essentially odorless, the pollutional characteristics and volume of the waste are reduced, and the minerals are concentrated. The processed waste still requires storage space and application to cropland, but several of the objectionable features of unprocessed wastes are reduced considerably. There are several different systems used to process organic wastes aerobically, but the three systems that have received the most attention for animal manure are the indoor oxidation ditch, the mechanical aerated lagoon and the naturally aerated lagoon. Naturally aerated lagoons, however, will have limited use due to their large surface area and water requirements. For example, an aerobic lagoon to process the manure from 1,000 head of swine would require a surface area of 19 acres and over 15 million gallons of water to fill it initially for operation. It is also doubtful whether the relatively small volume of manure added would maintain a satisfactory liquid depth in the lagoon.

Oxidation ditch for swine

Although some manure from animals other than swine is being processed by the oxidation ditch, most field experience has been with swine manure. In Canada there are a few oxidation ditches operating in commercial-sized swine barns but in the United States several hundred ditches are operating mainly for control of odors in the barn and storage and during land application.

The oxidation ditch in northern climates is an indoor continuous concrete channel, usually shaped like a racetrack and located beneath the slotted floor section of the pens (Figure 10). Most ditches are operated on a continuous flow basis where the ditch is kept full to the level of an overflow sluice gate. An aeration device (or devices) located within the central one-third of the straight section of the ditch, adds oxygen from the air and mixes the liquid, called mixed liquor, by circulating it around the ditch. The effluent (mixed liquor) passes over the sluice gate into a storage structure. Although the effluent usually has little odor, it has a BOD_5 of about 2000 to 3000 mg/litre and is not suitable for direct discharge to a natural body of water.

Very little information is available on the volume of effluent produced. In a British Columbia operation, an effluent volume of up to 10 times the calculated manure volume added to the ditch was caused by waterers that allowed swine to waste water excessively. On the other hand, the effluent volume observed at several Michigan and Ohio operations was only about a third of the manure volume added to the ditch. Increased evaporation by the rotor action undoubtedly accounts for liquid losses, but ditch leakage is also possible.

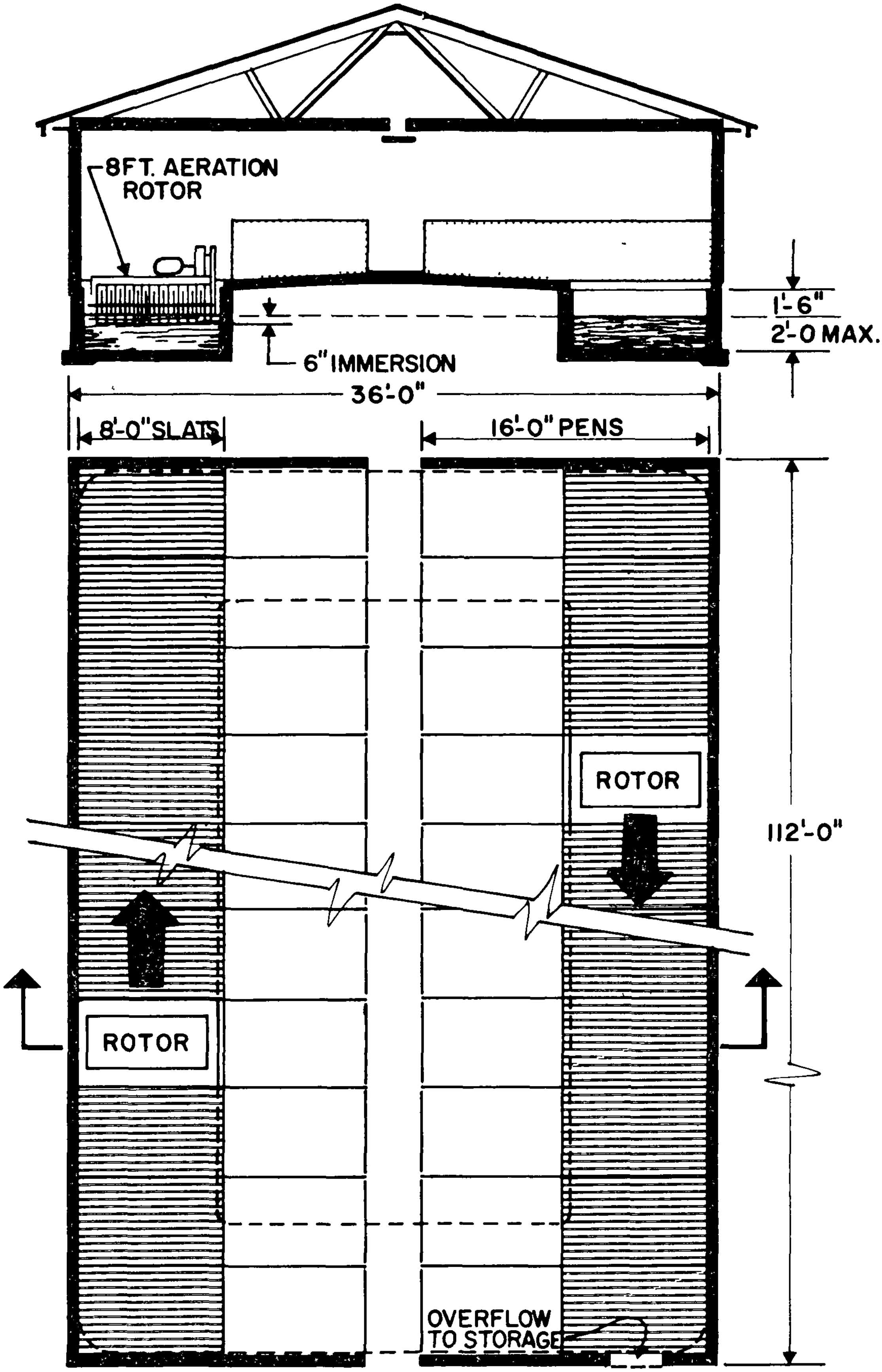

Figure 10 The Indoor Oxidation Ditch Located Beneath the Slotted Floor Sections of a Swine Building

Field experience indicates that the daily power costs for rotor operation are about ½ to 1 cent per hog based on an electricity cost of 2 cents per kilowatt-hour.

Mechanically aerated lagoon

In principle, the biological reactions in a mechanically aerated lagoon are essentially the same as those in an oxidation ditch, except during the Winter. Mechanically aerated lagoons for manure are in the field trial stage of development and several different methods of operations are receiving attention.

An aerated lagoon is mixed and supplied with oxygen from the air, usually by a floating mechanical aerator, although field trials with different types of air diffusers located in the lagoon are being conducted. Since these lagoons are located outdoors, very little biological activity takes place in the Winter and freezing problems in many parts of Canada can be anticipated. The manure handling system must also be designed to add manure to the lagoon at least daily to avoid upsetting the biological activity.

Some suggested design and operation recommendations based on limited experience have been published for mechanically-aerated lagoons, but since they have not been thoroughly field tested, they should be used only as a guide. In most parts of Canada, these lagoons should be considered only for seasonal use when mean temperatures are above 32°F.

Dehydration

In the dehydration process, manure is dried to a moisture content of 10% or less by the addition of heat. At this moisture level, the manure is relatively free from odor and can be further processed into a granular soil conditioner with low fertility analysis suitable for marketing. Considerable experimental work in several parts of the world is also being conducted on the use and nutritional value of heat-dried manure as a part of the feed ration for animals.

Currently, a drying study using poultry and dairy cow manure for re-feed to animals is under way at Truro, Nova Scotia under the supervision of Don Gunn who is with the Nova Scotia Department of Agriculture. They are just getting this project started. They are working with the animal science people to look at the value of pasteurized organic protein, POP, as a source of protein for re-feeding to animals.

Limited amounts of dried manure for fertilizer are presently being produced in a few dehydrating operations in Canada and the United States. However, several aspects should receive careful consideration before construction. Past experience has shown that manure-drying plants have gone out of business for two basic reasons; they were found to be uneconomical and a public nuisance. The economics of dehydration depend on the volume and moisture content of the raw manure, which affect the operation costs of drying, and on the non-farm market demand for dried manure. To minimize nuisance, additional expenses will be required for air pollution control devices, such as cyclone separators to control the discharge of manure particles and afterburners to control the discharge of odorous gases.

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Commercial driers specifically for manure have recently become available but sufficient field experience has not been gained to determine the range of conditions under which they are suitable. Due to recent increases in fuel costs, current costs of dehydration are about $50. per dry ton of manure.

Incineration

Incinerators are used to dispose of sewage sludge by drying, burning and reducing the sludge to ash. Sludges with a high proportion of volatile solids will burn without additional fuel once combustion is started, but other sludges usually require the continuous addition of fuel. Supplemental fuel is always necessary to establish combustion temperatures.

Except at some animal research laboratories, there are no known incinerators used to dispose of manure. Incineration greatly reduces the volume of manure to an inert ash, but odor and other air pollutants produced require control. Present equipment and processing costs do not appear to make this process economical for manure unless some new modification to existing types of incinerators is developed.

Composting

Composting of manure is a process that is receiving increased interest and some recent field experience and experimentation. Composting under aerobic conditions is a relatively fast and low-odor biological process where organic matter is broken down by bacteria and fungi to produce a dark-colored humus, carbon dioxide, water and heat as the main end products. The material heats naturally during the process and reaches temperatures ranging between 120° and $160^{\circ}F$.

The basic requirements for composting are the mixing and aeration of raw material that has a carbon to nitrogen ratio between 30:1 and 50:1 and a moisture content between 40 and 55%. To obtain a suitable raw material, most manures require the addition of dry material with a high carbon content. Chopped straw, ground corncobs or other crop residues have been used, and the possibility of using municipal garbage as a source of carbon, has been investigated. The process requires continual attention. It has operated successfully under Canadian Winter temperatures, but should be sheltered to allow suitable control of the moisture content.

Two processing systems used are the open windrow and the high-rate mechanical composter methods. The process takes up to a few weeks to complete using the windrow methods, where the material is placed in rows about 4 feet high by 8 feet wide and turned several times to mix and aerate. Stable compost can be produced in 5 to 10 days using the high rate composter method where the material is mixed at least daily and an aeration system adds oxygen. The compost can then be stockpiled to mature further; it is not overly attractive to flies and usually has only an earthy or slightly musty odor.

Before finishing compost I think we should make mention of the wet composting or thermophilic aerobic processing. Commercial interests are working in this area. At the University of British Columbia the agricultural engineers and the animal scientists have got together and they are using the thermophilic aerobic process on animal manure. They are starting feeding trials using the processed manure as well.

Slide Presentation

Before we get into the series of slides, I would like to say that I am on the executive committee for a symposium which is coming up on April 21-24, 1975 called the Third International Symposium on Livestock Waste. It is to be held at the University of Illinois, in Urbana, Illinois, U.S.A. Each and everyone of you are cordially invited to attend this conference. There will be one hundred and eighty papers given at this one, so there will be lots of information. The objective of the organizing committee is to try to get as many papers given at this symposium that would apply to solutions to field problems in the animal manure field.

Slide 1

This slide is courtesy of one of your own local people, Don Gunn, extension agriculture engineer here in Nova Scotia. We have known of this work for some time. This is a plastic cover over a lagoon, anaerobic lagoon or anaerobic manure storage. Whatever you want to call it, it is basically outdoor storage for manure. To control odor, Don has come up with an idea of covering this lagoon with a plastic sheet and a tube is brought around the periphery of the cover and the tube leads down into the soil and underground like a tile drain. The gases that are given up by the anaerobic digestion process are carried through the tube into the soil and doing a very good job of controlling odor. Don has just finished installing a more durable fibre and synthetic composition cover over this same unit.

Slide 2

This is some work that is going on in Edmonton, Alberta. In the background is the first cell of, again what we'll call a lagoon system. The manure is discharged into the first cell where most of the settled solids remain. This is for swine. It overflows through this tube into the second cell and in case of extreme flows there's a third overflow cell. They were interested in seeing how well they could agitate the solids in this first cell of the lagoon system. The suction pipe is used to lead to the pump and the pump leads to a 6 inch irrigation line and the manure is sprayed onto the land. They are operating a sprinkler that operates at around 700 gallons per minute at 130 psi so they're after a fairly high capacity. The sprinkler unit that is out in the field is a Rainbird sprinkler with 1½ inch diameter nozzle on it.

Slide 3

To show you an example of some of your storages, this is actually from Sussex, New Brunswick, built 6-7 years ago roughly. This is an example of one of the plans of the roofed liquid manure storage for swine manure.

Slide 4

This is an example of the above-ground storage out in British Columbia in a high rainfall area of the Fraser Valley. It's doing very well for holding liquid manure.

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Slide 5

For semi-solid manure, this is an example of a kidney shaped storage which has a swinging stacker with the wall curved to accommodate it. The stacker has never moved. The material, even in the dead of the Winter, moves just like a glacier. It keeps moving out as it's deposited into the manure storage.

QUESTIONS ON MR. HORE'S PRESENTATION

Question: (A. Kumbhare, Environmental Protection Service, Environment Canada, Halifax, Nova Scotia) Do you have any idea as to what farm size, or for what animal units, these units are economical?

Comment: (Mr. Hore) That's Professor Webber's category.

Answer: (Mr. Webber) We have come up with some guidelines in Ontario as to the economical size of unit. I think that it is something in the order of a hundred milking cows.

Those figures were worked out several years ago.

Comment: (Mr. Hore) I may add that the Guide has a section written by soil scientists like Mr. Webber and that they could not agree that we could put together a table, even on a regional basis, to look at recommended rates of manure application. The final statement is that one should go back and consult local authorities in connection with this business of application rate, land requirements, for the utilization of manure.

Question: (Mr. D. Gunn, Nova Scotia Department of Agriculture, Truro, Nova Scotia) I think one of the things I'd like to hear comments on, maybe from both Mr. Hore and Mr. Webber, is this application rate. I'm not expecting definite answers because I don't think we have any for all our soils but our farmer friend from the Island has expressed some very good views here about the uses of manure as a fertilizer in view of the fact that these increasing costs of nutrients indicate that we may not be able to get them sometime in the future. Our manures are naturally becoming more and more valuable. Our other concern is what are going to be acceptable rates for this material. Are we in some kind of a position to advise farmers, on the large variety of soils we're dealing with, what these application rates can be for different crops?

Answer: (Mr. Webber) If we go back to a paper we gave in New York State at an Animal Symposium several years ago... after a limited amount of research and reading, we came up with the value 300 pounds of total nitrogen per acre. It has been a value that a lot of people have taken swings at and have taken a poke at and I'm not so sure we're very far wrong. Now the limitation on that value, 300 pounds of total nitrogen, is that it is for corn production in our area. It is for hay or grass production and it is on a medium to a fine textured soil. It is too much to put on a sandy soil. It is too much to put it on a coarse, porous, open soil in that region. So we are still standing on that until somebody pulls out our legs from under us.

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We have some research that I've referred to earlier on the application of sludges, anaerobically digested sludges where, in half an inch application there is more than enough nitrogen to produce a crop of corn. Therefore, you have to know the total nitrogen content of that sludge because only about half of that is readily available to a crop. We have reached another opinion which is sort of a rule of thumb, it's not very scientific, but we operate on the rule that you need about 1 pound of nitrogen to produce a bushel of corn. I guess that is the best we can do at the present time.

Comment: (Mr. Hore) I would just add one more thing to Len's comments. There are studies being conducted on this business of rates of application and time of application. We, in Ottawa have 14 plots where we are looking at three different rates, 200, 500, and 800 pounds/acre of nitrogen - a reasonable spread. We are looking at those three rates applied in Spring, in Fall, those rates split in half in Spring-Fall, and Winter applications. Of the other two plots, one plot is a control and the other is commercial fertilizer based on soil recommendations. We have just got this project nicely off the ground. We don't have any results at this time but I think in another year we should have some kind of first glance at what is happening. We are monitoring the input, as far as nutrients are concerned and the crop yield. We are measuring the output from surface run-off and from tile drains (or the subsurface flow from these plots) as well.

Question: (Mr. Gunn) Now, this is an acceptable rate then for crop production. Is there a limit that a farmer could go to and still not cause a pollution problem if he has more manure than this amount? I mean, is there another figure that he can really over-apply and still not cause a problem in the water supply?

Answer: (Mr. Webber) No, I'm still sitting tight on 300 pounds. I'm saying, if you go beyond that you're going to get into groundwater pollution, I'm sure of it.

Question: (Mr. Webber) What do you expect, Mr. Hore, to get with the Fall application of manures? If you put the manure on in the Fall, you may get some warm weather suitable for oxidation and nitrification. The nitrates might get away on you.

Answer: (Mr. Hore) This is what you have been concerned about from a soils point of view. We are looking at it because we are normally thinking in terms, at the present state of technology, of 6 months storage. Unless you have cropland available where the manure produced between Spring and Fall can be applied continually during this period, Fall and Spring application is necessary.

Question: (Mr. Webber) So, it is a convenience, because, generally, you would not recommend the Fall application of manures or a commercial fertilizer.

Answer: (Mr. Hore) That's right.

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Question: (Mr. J. Nicholson, Agriculture Canada, Fredericton, New Brunswick) We are interested in the use of animal manures as livestock feed. There is one other method of preserving this material for livestock feedings that hasn't been mentioned and that is to sile it. It does effectively sterilize the materials so that the pathogens, or potential pathogens are not a problem in the material when it is fed. I just wanted to say there is one more way in which this material can be preserved for livestock feeding.

Question: (Mr. Hore) Are you working in this field?

Answer: (Mr. Nicholson) We haven't started any work yet, but people at the ARI. (Dr. Fisher) are. The people at Guelph are working on this as well with chemical treatments, sodium hydroxide treatment.

Comment: (Mr. Hore) Yes, there are a number of studies going on. Actually about a year ago at an agricultural engineering conference in Calgary, I tried to bring together a paper and put in tabular form the current research that was going on at that time. I got information from our research operating grants and from other publications which list the projects that are being conducted across Canada plus my own knowledge of it. There are something like 52 different projects in this area of animal wastes and waste management that are dealing mostly with manure. Some of these are showing up where the animal scientist is involved. You mentioned the Guelph work; I believe there's work going on also in some of the western agricultural colleges as well.

Question: (Mr. Webber) Coming back to this question of recycling animal by-products back to animals, could someone in the audience tell me, whether the Maritime Provinces have any restrictions on feeding, say raw manure, back to beef cattle or that type of process? Are there any restrictions at the government level on that process?

Answer: (Mr. Gunn) There is no restriction on the farmer as long as the product is not sold through a registered feed mill. As I understand it that is Canadian law. That is the best information I can give. It is our understanding that that's the law of our country.

Comment: (Mr. Hore) Just to expand on that, the position of our Plant Products Division, which is in the Production and Marketing Branch, is that the product must show no evidence of disease transfer nor drug residue. Regarding drug residues they feel that studies are still needed on both the levels of drugs in manure as well as the levels of drugs that might end up in the animal tissue itself. This is where they stand at the present moment.

Comment: (Mr. Gunn) One of our objectives, before we began the POP project, was to work very closely with the people who are concerned with the control of all the feed materials for livestock in Ottawa. They are doing quite an extensive sampling procedure of all animal feeds where livestock manures are being recycled. This is not being done under the table at all. It's being extensively sampled and analyzed since all the feedings operations have begun in the province quite a few years ago actually. In our project we are sending samples regularly to Ottawa for analysis and we hope that

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it will get a "yes" or "no" on the use of these products. It will be in the interest of farmers and all of us. A lot of countries are trying to get laws established, so it will be clear to the farmers and livestock feeders what their position should be on this. I think we realize that this work was really started at Michigan State some twelve years ago and as yet the laws are not clear in the United States. I think they are on a big, high shelf right now. There was every indication that they were going through this Spring but now they're back up on the shelf.

I think it's awfully important that people get this cleared up.

Comment: (Mr. Webber) We have outside of Kitchener a rather large livestock feed producer and he was doing very well feeding raw manure to his beef cattle. The local consumer's association heard of this and they boycotted his products to the extent that he had to cease and desist. This is what I consider a very sensible and important way of recycling so-called wastes. The people, the public, virtually forced the change.

Comment: (Mr. Gunn) Well, that's an important point. We were vitally concerned about public pressure in reaction to the project we were doing and, I don't know if any of you have read the press coverage on it, but the thing that both surprised and pleased us, was that we didn't get a single bad reaction. We got some phone calls complimenting the project....that we were doing something to use the material that was normally known as a waste. We had some people come and look at the project. I don't know why this has happened. We did make an effort, before it was announced, to contact people in the press who are noted for grabbing hold of something a little different and blowing it up out of proportion. I've been telling them that we're glad to work with them and give them all the information we have. That might have helped.

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FOOD PROCESSING WASTE TREATMENT and DISPOSAL

Mr. Vaclav Kresta

Pollution Control Branch

New Brunswick Department of Fisheries and Environment

Fredericton, New Brunswick

Introductory Comments: (Mr. Fedoruk)

This afternoon we're starting with Mr. Vaclav Kresta who will be talking about food processing waste treatment and disposal. Vaclav is presently an engineer with the New Brunswick Department of Fisheries and Environment. He started out in Prague, Czechoslovakia where he received his BA degree in Chemical Engineering. After a few years of work in the chemical industry he joined the Water Research Institute of Prague. For more than twelve years he was involved in laboratory and pilot plant research for industrial waste treatment. In 1969, Mr. Kresta came to Canada to take post-graduate studies at the University of New Brunswick, where he received his Masters of Science degree in Civil Engineering in 1970. At present, he is responsible for mining, food processing and agricultural wastes in the New Brunswick Department of Fisheries and Environment.

Mr. Kresta... Mr. Chairman, I am very pleased that I was invited to speak at this seminar, though I must admit that I was a little reluctant to accept this invitation for the simple reason that solid waste disposal is not really my field of expertise. However, because the quantity of industrial solid wastes which are finally disposed depend, to a large extent, on the in-plant house keeping and to recovery practices it wouldn't hurt to mix this aspect into the subject of the seminar.

You will probably agree with me that we should not ask Nature to do the job for us and clean up what could be taken care of by the industry. I hope that you will agree with me that this should be the rule even in such a comparatively unspoiled environment as we have in the Maritimes. Mother Nature is sometimes capable of correcting our failures. We are learning from experience and experience comes from bad judgement. As a result, our demands often were too great.

I have come to Canada from a central European country. All of central Europe is heavily industrialized. It is a centuries old tradition. In the past, people didn't have the knowledge and did not realize what kind of havoc they were creating for future generations by dumping liquid and solid wastes without too much concern. The awareness came much later almost when it was too late. They believed that the streams would be capable of assimilating the wasteload and the industrial effluent. They believed that the land would tolerate the abuse and absorb the solid waste from open pit mining, chemical industries, pulp and paper industries and also food processing plants. They were wrong. There are industrial areas in Europe where stream water is

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being reused up to 13 times. I mean the whole flow. You may believe me for I have done a survey in one such area. They had to build aquaducts up to 100 miles long in order to supply industrial centres and large cities with good quality drinking water and water for industrial use. In Switzerland in the '50's there were houses and mansions on the shores of lakes which used to be clean and pleasant where no one would buy those houses even though they were cheap simply because of the terrible odors of the lake waters. In coal mining regions there are areas, miles and miles of landscape, which do remind one more of the moon that of anything on our earth.

You might be wondering why I am speaking about that but you know as well as I do that similar conditions can be found on this continent, in Canada, and even in the Maritimes. Here, in the Maritimes we are however lucky, lucky that in most cases it is not too late that we can catch up and make sure that our provinces will get the industry they need but won't suffer beyond reason because of our activities. We have more know-how, we must find the time and the willingness to care and to evaluate the limits. We must abandon the attitude so often heard, "My waste, it's nothing, why bother? Why me? The other guy is not doing better". Solid wastes, especially the garbage, the household garbage, spread around our provinces whenever you enter a bush, don't indicate that the people in the Maritimes really care too much.

In this context what is being done with industrial solid waste, in general, and those in the food processing industry in particular? Unless there is some easy and obvious use for them, the solid wastes are transported to a dumpsite, usually located as close as possible to the production in order to save on transportation costs. Fortunately, a great deal of solid waste generated by the food processing industry is or can be, utilized directly as a livestock feed or processed into livestock feed ingredients.

Let us first examine the fate of wastes for which there is no or little chance for utilization and which, therefore, is deposited on an industrial dump in hopes that everything will be okay. Usually it isn't especially in cases where the solid wastes are more liquid than solid. In fact, if you have a closer look at the situation, you will find out that a great deal of so-called solid wastes are, in fact, semi-liquid.

This holds true, especially for the potato processing industry which is one of the biggest producers of solid or other semi-solid waste in New Brunswick. When the potatoes are processed into french fries or potato chips, there are only two groups of true solid wastes - the "stones" which pose no problems, being mainly inorganic and the "cuttings" and "trimmings" which pose no special problem anymore, at least in New Brunswick because they are recovered and either processed into a saleable product, like potato mash, or potato granules or fed to cattle. But the rest are sludges and sludges are the worst kind, at least in my opinion, of solid waste we have to deal with. In the potato processing industry there are four major sources of sludges - the mud from washing potatoes, the sludge from peeling potatoes, the sludge from the primary clarifier, the sludge from the secondary clarifier, if that particular plant has biological treatment. From these four, only the sludge from the primary clarifier is readily amenable to dewatering, for instance, by vacuum filtration.

As long as the in-plant recovery of organics is efficient, the sludge, at least in larger potato processing plants, consists mainly of the mud from potato washing. In smaller plants, where abrasive peeling is still in use, the sludge may also contain this waste. But all the other sludges contain no more than 10 to 15 percent solids. And if the dewatering of the primary sludge fails or becomes too expensive, then the primary sludge is not better as far as solids are concerned. Lye peeling which is used in all larger potato processing plants is the source of the biggest headache. The sludge is usually collected separately and so far land disposal is the only method of getting rid of this waste. To have an idea of the quantities involved a typical french fry manufacturing plant generates at least 100 tons lye peel sludge per day. It's true that the potato processing industry is trying to find a way for achieving a higher solid concentration of the lye peel sludge and this would reduce the cost of transport and storage if the waste is fed directly to cattle or perhaps allow drying and mixing of the dried slurry in potato meal.

In the disposal of liquid wastes, our main concern is what will happen to the liquid portion. The supernatant in the ponds where lye peel wastes are stored has a tremendously high BOD_5. It is around 10,000 milligrams per litre. There are, theoretically, three alternatives to get the liquid fraction to disappear from sight - infiltration, discharge by seepage or by overflow and storage. Neither of the two first alternatives is what we would like to see. A permanent storage is not a workable solution either. In our latitude, precipitation exceeds evaporation roughly twice. If you want it more precisely, 40 inches relative to some 18 to 22 inches. This does mean that on the average more than a foot of the berm would have to be added to the height of the embankment each year to compensate only for the precipitation if there is no significant loss of water from the pond. I probably won't be unjust to the industry in saying that the industry hopes that the liquid portion will reach the groundwater strata and disappear without noticeable effect. It looks like once the dump is filled to the free-board these hopes are in vain.

There are data in the literature suggesting that the bottom and walls of ponds filled with wastes high in organic matter seal off rather fast and that there is not too much downward movement of water afterwards.

One dump we have studied is now in use for the third season. The third season has started. Its present volume, after several increases in the height of the embankment, is very roughly 5 million gallons assuming an average depth of ten feet. The potato processing plant operating about forty weeks per year is holding there on the average 24 loads per day, each 15,000 pounds or 1,500 gallons per load. Just about 14 million gallons of waste were brought there in the past 2 years. The ponds have an area of 2 acres. Let's assume that the excess of precipitation is only half a million gallons of water. Altogether $14\frac{1}{2}$ million gallons of water should be in that storage pond. You will remember that I told you that the actual volume at present is roughly 5 million gallons. This does mean that 10 million gallons of the supernatant have disappeared from the impoundment. The rate of seepage varies. Most of the time, we have measured rates around 6 gallons per minute. This indicates that some 6-7 million gallons escaped through this outlet in the past 2 years. The remaining 3-4 million gallons, more or less, were probably lost by infiltration in the early days of the plant's operation. I will explain right away why I am saying in the early days.

Before that I'd like to make you aware that the BOD of the seepage is 8,000 milligrams per litre and that, in other words, the dump has released to the environment during those 2 years as much as 800,000 pounds or 400 tons of BOD. This, for sure, is not a good example of taking care of our environment.

The assumption that there should be little seepage through the bottom of waste holding ponds after an interim period is supported by the findings reported at this year's conference on processing and management of agricultural wastes held in Rochester, New York. The California State Water Resources Board measured the extent of water seepage through the bottom of manure holding ponds as a function of time after their construction. Seventeen holding ponds holding cattle manure were selected so that the soil texture varied from sands to clay loams. The hydraulic gradients were measured, the soil solution under the pond was analysed and when all these and other data were evaluated they came to the following conclusions:

(1) During the first ten days there was a pronounced seepage but after the ten days the hydraulic gradient sharply dropped and there was another period of about 25-40 days when it remained at the same value, approximately half of the original value.

(2) Then it decreased again and finally approached near zero values. In other words, after 30-60 days all soils, including those containing mainly sand, sealed off and downward water movement virtually stopped.

Another research group at the University of California studied what is happening directly in the soil. In an article published a few months ago they explained the mechanism of soil sealing at the bottom of waste water holding ponds as follows. In the first phase physical clogging is occurring at the near surface zone of the soil. Suspended and colloidal material is trapped in the pores and voids. This process, mainly physical and chemical in nature, contributes to the initial decrease of the seepage rate. It doesn't stop, however, the water movement completely. In the second phase of soil clogging slime-forming micro-organisms get engaged and mucus-like materials or gums are formed. An increase of polysaccharide materials in the soil has been determined and it has been observed that the increase of this material corrolated with the decrease of the seepage rate. In the case of clay, loamy and sandy soils the biological clogging virtually sealed off the soil for further water movement. Those studies were laboratory studies.

In essence, it is possible to conclude that sealing of animal waste water ponds takes place. It is caused by both entrapment of particles of organic nature in the soil followed by the growth of micro-organisms. The texture of the soil ranging from sand with no clay to silty clay with 80-90% clay, influences only the time it takes to stop the water movement. Present data indicate that about 2 months are enough for all textures. A word of caution is necessary. The above group also found that once the soil dries out the impermeability caused by bacterial action is lost. I haven't decided how to cope with this in cases when the lagoon is periodically emptied, which is happening with agricultural wastes. The findings do however, help to understand why the potato processing plant had to raise, from time to time, the height of the embankment in spite of the losses by seepage.

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True, all these tests were carried out with ponds holding manure but why should a potato sludge create different conditions? On the contrary, probably, the presence of very fine particles in the abundance of easily degradable organics should speed up the process and if this assumption is correct then at the moment that the pond seals off all excess water must be either accumulated or the overflow properly treated. Treatment of the supernatant is the only approach I can think of which would make the present way be acceptable from the point of view of taking care of the liquid portion.

There are, however, other reasons why land disposal of the lye peel wastes in confined storage areas is a poor approach calling for a better alternative. One of them is the danger that the embankment might simply fail causing a disaster. The other is the terrible odors which spread for miles and miles and result in numerous and quite understandable complaints from local residents. Let's keep our fingers crossed and hope that the efforts of the potato processing industry to utilize the lye peel sludge are successful.

As far as the primary sludge is concerned, I can't see any other way than land disposal after proper de-watering. If most of the insoluble organic solids, including starch are removed by in-plant measures then the sludge will be mainly inorganic and there shouldn't be special problems. Actually, when the first dump was operated in that way it was unsightly but there were no odors.

As far as sludges from secondary treatment are concerned the problem is more difficult to solve and I am afraid that more research is necessary in order to find alternatives for land disposal. I cannot disregard the feeling that this sludge could be utilized as a cattle feed ingredient as well.

You have undoubtedly noticed that thus far I have dealt only with the problems related to wastes from processing potatoes into french fries and potato chips. Solid wastes are also generated by potato starch manufacturing plants. There used to be two in New Brunswick, however, they ceased operation gradually. They didn't have any facilities for pollution control. One of them will be re-opened this year. As far as true solid wastes are concerned, there shouldn't be, theoretically, severe problems. The mud is inert and the potato pulp is a good cattle feed either as such or dried. If there is no use for it, it could be buried in a controlled way. That is what the company is promising. The treatment of liquid wastes, especially of protein water, is however an extremely difficult and expensive task. Evaporation was suggested about 2 years ago. I am afraid that now the cost of fuel would be prohibitive. Biological treatment would probably need a two stage process in order to keep the volume of sludge reasonably low and this is expensive too and there is not too much experience. The only method considered acceptable and feasible by the starch industry abroad in Europe, say in Holland, or in the States in Idaho, is spraying protein water on land. In our latitudes, however, land is frozen or covered with snow when starch wastes are generated or if the disposal would be from time to time it would freeze over and prevent any further infiltration of the waste into the ground. Therefore, land spraying would hardly be a good approach in our provinces. The re-opened plant has been given a year to propose a treatment for the liquid wastes. I am, however, afraid that once again we will have to deal with the problem of sludge disposal

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if conventional treatment is employeed.

I think it's time now to leave the potato industry and have a look at the second major producer of solid wastes in the province and this is the fish processing industry. There is a significant difference between the two industries. Whereas only about fifteen percent of the potato weight is lost for human consumption and disposed of either on dumps or fed to cattle, thirty to seventy-seven percent of landed fish is non-edible. The non-edible portion of the fin fish, the fish offal, can be processed without problems into fish meal. The great majority, indeed, is. Only the small plants located too far from existing rendering plants do not have any other choice than to dump the offal on land. They are too small to have their own rendering facilities. It is unnecessary to say that there are problems and I will discuss them a while later.

Before that, I would like to stress the importance of good in-plant recovery practices. The fish wastes differ somewhat from other food processing wastes. They have a tendency to disintegrate which makes recovery more difficult. For this reason the time of contact of solids with water must be minimized in order to reduce the disintegration and also leaching. In other words, solids should be recovered not only efficiently but also as soon as feasible. The type and condition of facilities employeed for the recovery of solids is therefore of great importance. It's obvious, that large amounts of screen trapped or conveyor trapped solids significantly contribute to an increase in load of the waste water and would also reduce the value of the fish offal as a raw material for fish meal production. The facilities used for recovering solid fish waste range from a simple catch-box with perforated walls mounted on the lower end of a conveyor to rotating screens ranging from 4 to 16 mesh to solid state tangential 25 mesh screens. I won't spend too much time discussing the importance of a liquid screen. This has been done in the course of preparing and discussing the guidelines for this industry and if you have any questions I will try to answer them in the discussion.

Now to the comments. The industry, especially the small producer, is not aware of how many solids they are actually losing by not having proper screening facilities. They are surprised by what the simplest equipment, a well-designed rotating screen, can achieve. Only after having installed that type of facility do they realize how many solids they were losing.

The second comment refers to the results we have from the first tangential 25 mesh fine screen in operation in the province of New Brunswick. It was installed this year. It's handling herring filleting wastes and shrimp peeling wastes. I must state that at the time of our sampling one link was missing; namely the equipment for removing the coarse solids. Instead, all the wastes went into a large pit from where it was pumped directly onto the final screen. On the day of our survey, 191 tons of herring were processed in 18 hours. The concentration of suspended solids in the 270 gallons per minute of room water was 1,500 milligrams per litre on the average. This is, in my opinion, still a rather high figure. I would think that the results could be better and will be better when the removal of solids is done so that the coarse solids are removed first.

For comparison, there is in the province a herring filleting plant which was operating without fine screening. They had only a de-watering conveyor. The average suspended solids concentration in their effluent was 3,900 milligrams per litre or about 2,400 milligrams per litre higher. If this figure is used, the former plant would have lost 6,000 pounds or 3 tons of solids worth about $120. at that time during the eighteen hour operation if they didn't have fine screens. In other words, 1.6% of the fish processed.

I have mentioned that some of the fish processing plants are too far from a rendering plant and have no other choice than to get rid of their wastes by land disposal. I am now talking about ground fish or herring processing wastes not about shell fish wastes. Our experience with offal dumps is poor. If the offal would be covered properly and right away there shouldn't be problems if the site is far enough from streams and dwellings. Unfortunately, covering is only seldom done properly and in time odors and flies spread around the country, complaints are pouring in, and government agents are travelling around the country to persuade the operator to do what he was supposed to do immediately. The worst conditions develop if a trench is dug in advance and is only gradually filled with fish offal without covering. Juices are released from the decomposing wastes and the leachate accumulates in the trench. You can easily imagine what this does to air pollution. Even worse conditions develop if the trench is on a sloping ground. Then the juices and leachate fill the lower end of the trench and it simply overflows.

We have a combination of all these circumstances at one dump site in the Shediac area and the trip over there would give you an idea of how a dump should not look like. Unfortunately, I can't tell you of any location where you could see how it looks when things are done properly. As a matter of fact, this is not realistic because you should see nothing. In my opinion only a bit of care is all that is really necessary to have the offal buried and covered properly.

The main problem is the availability of proper machinery for covering and this is what the small fish processing plants do not have. Good co-operation with the Department of Highways is hard to negotiate because of the irregularity of dumping and also because of the usual minor quantities of waste involved. Thus, we have a problem which is very difficult to cope with. Any suggestions are welcome.

Compared with fin fish offal the shell fish offal represents a less serious problem in terms of nuisance, at least if it originates from large processing plants. There are two reasons for this.

1. Because of the large quantities, these plants can usually choose a site remote enough to permit simple piling of waste without covering, and;

2. In the larger plants their shells are flumed from the processing area and thus, most of the putrescible organic matter is washed away.

Washed crab and lobster shells left in the open usually disintegrate within a year or so without too noticeable odors or other nuisance.

Once again the small plants where the carb and lobster is handled by hand are the sources of problems. All the non-edible portion remains on the shell and would decompose on the dump and create nuisance if not properly covered. Since there is, at least at present, no other way of getting rid of the waste than land disposal the only way of doing it safely is to observe the rules for sanitary landfill operations. But here we are again, the small shell fish processor simply does not have the equipment for covering the wastes.

One of the possible approaches would be to have the wastes dumped on a municipal dump site operated as a sanitary landfill operation but we don't have such things in rural areas. So you see, we really have a problem.

You have probably heard of the efforts to produce shell fish meal from some of the wastes. Unfortunately, shell fish waste meals have limited markets due to their high mineral and chitin contents. These two components limit the levels at which shell fish meal can be fed to farm animals and poultry. Chemical separation into the three main components chitin, protein and calcium carbonate is feasible. It is known but it's an expensive process. If there is any chance at all that this technology would be employeed commercially such plants would be once again most probably located only at major centres of shell fish processing and the small operator scattered around the country and causing the headache would be left out again.

Let's now spend some time with the rest of the food processing industry. Compared with the potato and fish processing plants, the rest of the food processing industry represents at least in New Brunswick, a minor problem in terms of quantity and strengths of the solid wastes, if I may use this term. This does not necessarily mean that on a local scale even a comparatively small operation could not become a headache.

One group of plants prone to be a source of problems is slaughter houses and poultry abattoirs. With good housekeeping practices, there shouldn't be serious problems. The manure including paunch manure should be returned to fields or disposed at an approved land disposal location and the non-edible portion of the animal or bird collected for rendering. Except for manure, and in some cases blood and grease, recovery of solids is quite efficient because there are dollars involved.

As in the fish processing industry, the handling of solid wastes is more a problem of proper collection than a problem of their disposal. This can be well demonstrated in the case of feather recovery in poultry abattoirs.

It looks like the time assigned to my talk is running out. I am, in fact, quite happy. Not because one hour of talking should be enough but because there is one more sore spot. Namely, the disposal of agricultural potatoes and here good advise is really difficult to come by. This problem arises when there is an overproduction of potatoes damaged by frost like this year or perhaps other factors. Last year we were lucky. We didn't have starch processing plants and we didn't have too many problems. There are, however, years of high crop yield and, I hesitate to say, low prices. In such a year it is estimated that 12-15% is non-marketable but fit for starch processing or some other secondary use. This represents some 130 million pounds or 800,000 barrels of low grade potatoes in New Brunswick based on an average crop of 13 million hundred-weights in recent years. If there is no other use we are faced with uncontrolled open dumping. This is not only an obvious insult to the environment but may also be a hazard to the quality of future crops not mentioning the nuisance because of odors.

There are basically four alternatives for handling agricultural waste potatoes and each has inherit advantages and disadvantages.

1. The starch manufacturer. This is theoretically a very good approach but starch plants are going out of business because of economic reasons and because they cannot meet the pollution control requirements. In addition, if the plant is too far from the farm the cost of transportation could be prohibitive.

2. Processing to potato meal. We don't have any such plant in New Brunswick. There were efforts to build one but it was a half a million dollar failure and it is my understanding that the high cost for air pollution control buried this project. One such plant is operating in the State of Maine somewhere back in the woods. They don't have any air pollution control. This approach is generally considered to be one of the better alternatives since both the agriculture and industrial wastes, such as peelings, can be processed. In fact, one of the New Brunswick french fry manufacturing plants is hoping that their lye peel sludge will be processed in this main potato meal plant. The main deterrant besides air pollution control cost, is once again the cost of transportation.

3. Feeding to animals. This is theoretically the best alternative but only where feed lots are within reach or can be established. Otherwise the cost of transportation is once again excessive. There are, however, other problems besides the cost of transportation.

   a) The waste is strictly seasonal and won't support any larger year-round operation.

   b) Feeding raw waste to ruminants, including sheep, is okay but feeding to pigs lacks advantages since the potato must be cooked. In addition, potatoes are quite low in protein, only about 6%, and therefore, an economical gain can be reached only if corn or soybean meal is fed as a supplement.

   c) There is quite a high work load involved in collecting the waste and there is inconsistence in supply and all that is causing problems in the utilization as an animal feed.

4. Controlled dumping. There are two alternatives to control dumping.

   1. Dumping at the sacrifice site.

   2. Controlled dumping with crop rotation.

   The first alternative can't be anything less than a sanitary landfill if pollution and spreading of disease shall be controlled. Contrary to other industries the farmer has the equipment and therefore proper covering of the wastes could be done. This does not mean that it is done. We usually find the potato in the nearest highway ditch.

   The second alternative is advocated by the University of Maine. They figure it could work as follows. Municipalities would lease land and make it available for potato dumping for one year or so. Then grass would be grown for one year or two to utilize the nitrogen. The main advantages are reduced transportation problems and no dependence on waste volume if enough acreage is made available. They admit, however, that there are a few problems needing long term research to find out:

a) load capacity of different soils

b) how many years the land can be used and still maintain good soil quality

c) what soils can be used for this purpose

It's quite obvious that this alternative, even if feasible from the administrative point of view, needs lots of time before it can be used on a large scale.

To conclude, I'd like to add a few words. The thrust of the seminar is to provide guidance for disposal of waste on land. I have already mentioned that I am not an expert in that field. I understand that the challenge is to utilize the chemical, physical and biological properties of the soil as an acceptor for the residues of man's activities, with minimum affects on crops that are to be grown, to the characteristics of the soil, to the quality of groundwater and surface run-off and with minimum nuisance by odors.

Some wastes, such as manure including paunch manure, do not pose special problems. It's a centuries old tradition but still there are some questions not answered. With industrial wastes the matter is even more complicated. This applies to food processing wastes as well. I do hope I made it quite clear that in the food processing industry the best approach is to recover and reuse as much as can be utilized either for human or animal consumption. There will always be a continuing need for land disposal of some wastes. Because of the putrescible character of most food processing wastes the aspect of nuisance is one we have to deal with first. But there are other aspects, too, and they are equally important.

Unfortunately, engineers and scientists have been concerned about the assimilative capacity of streams, estuaries and lakes for numerous decades while comparatively little has been done and is known about the waste assimilative capacity of a soil.

The unanswered questions related to the disposal of waste potatoes is an excellent example. Surely we don't need to discuss that the old tendency to hide the waste in land depressions or other areas located some distance from our homes and those of our neighbours must be discontinued. Until such a time when we will have a better understanding of how much solid waste can be incorporated into crop growing soils we have only one acceptable method for the disposal of readily degradable solid wastes and this is burial in the ground in a properly controlled operation. This is certainly feasible with true solid wastes.

The solution for semi-liquid wastes is not that simple. I have spent a considerable portion of the time discussing this single problem. I've done so because I feel that it is one of the most pressing problems. I can only conclude that all effort should be made to ensure ultimate disposal of the waste rather than simple accumulating of sludges for future generations.

Thank you.

QUESTIONS ON MR. KRESTA'S PRESENTATION

Comment: (Mr. Nicholson) I'd just like to make a few comments concerning the use of potato processing wastes and culled potatoes for livestock feeding. This has been an area that has interested us for some considerable time and this is one of the by-product feed that's a little different than most of the ones that we've run up against in that most of our by-product feeds are low-energy, low-quality feeds. The potato by-products are a high-energy feed and this is the nutrient that's most often deficient in our Maritime rations because we do not grow enough grains to feed our livestock population. We import a high percentage of the grain that we use to feed livestock from western Canada. So, the potato can form a very useful part of many cattle-feeding ranches. The problem with many potato products is the high moisture content and the fact that it has to be mixed with other feeds to build the total dry matter content of the ration up to the point where the animal can consume sufficient dry matter per day. The big processing plants of the western U.S. that are successfully using even the dry peel sludge for cattle feeding are mixing this with other parts of the potato that are being discarded which have not been exposed to the chemicals. This material still has to be held for a period of time in tanks or pits of some kind to allow fermentation to reduce the pH to a point where it does not interfere with the digestive processes of the animals. If this is done there is no reason why this material can't be used for cattle feed. Similarly, the sludge from the clarifiers is used in every other area, where potato processing is a big industry, for feeding livestock. Again the only problem with it, from the point of view of feeding it, is the fact that you have to add other sources of dry matter to build up the total dry matter content of the ration. I think that this is one feed that serves a real purpose in our Maritime cattle feeding rations. I think on the Island they're in a much better position to use their cull potatoes and processing wastes because their potato production and cattle population are pretty well intermixed. In the potato growing area of New Brunswick, unfortunately, there are not enough cattle in that area. But it's an excellent feed and it should be used more and more ways.

Comment: (Mr. Kresta) I'm really happy to hear your comments especially on the biological sludge.

Question: (Mr. Fedoruk) You mentioned that the sludge from the primary clarifier can be utilized while there were problems with the sludge out of the final clarifier. What are those problems?

Answer: (Mr. Kresta) It is my understanding that the de-watering of the secondary sludge was unsuccessful. They tried to do that but for some reason, not properly explained, they have never continued. So what they have chosen is the way of the least resistance to take the sludge to the dump, unfortunately, only once a year so they are creating odor problems not only in the vicinity of the production plant because they have one lagoon there always and they store it a whole year and then at the dump site when they trnasfer it once a year.

Question: (Mr. Webber) Where are the lye peelings disposed of on soil?

Answer: (Mr. Kresta) Nowhere. Oh wait, I think that my colleague from P.E.I. can comment on that.

Question: (Mr. Webber) Do you have any problems with the amount of sodium or physical condition developed with the application of the relatively high amounts of sodium on the soil?

Answer: (Mr. Stewart) We have some experience with the disposal of lye peel wastes on the soil. We're recommending application rates not in excess of 50 tons per acre. As far as pH is concerned, pH is no problem. Whether sodium concentrations in the soil will be a problem, we're really not sure.

GUIDELINES FOR LAND DISPOSAL

Mr. W.C. Phillips

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Introductory Comments (Mr. Fedoruk)

For the last part of this afternoon we have Mr. Bill Phillips who will be giving a short talk on the guidelines for land disposal. This should produce some good discussion and after he gives his talk we'll have the four panelists at the front to discuss the topic. Bill indicates that before he graduated from Nova Scotia Tech in 1966 is somewhat obscure. I can understand that from Bill. In 1966 he was with the forestry in rural development in P.E.I. which covered a comprehensive government plan on resource management and land use planning. Then in 1972 he joined the P.E.I. Environmental Control Commission of which he became the Director of the Air and Solid Waste Division.

Mr. Phillips...I'd like to preface my comments in this way. First of all, I am certainly not an authority on the subject. From my own point of view, I sometimes question what I, as a member of the air and solid wastes management division, am doing up here talking about what is, essentially a semi-solid. I'd like to draw the line and say it's not my problem and hand it on to someone else. Because Prince Edward Island does not have a great deal in the way of firm guidelines and regulations in this area some of the points that I'm going to mention are going to be largely those in the realm of policy on which I am not qualified to speak. Secondly, I would like to thank the previous speakers.

It reminds me of a Professor I once had after we had gone through several detailed courses in structure, stresses and strains and the intricacies of reinforced concrete. He was teaching highways and highway design and

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he used to introduce his first day to every new class by thanking the previous professors for "paving the way" and he referred to them as his assistants which was always good for a laugh. So I'm going to plagiarize a great deal on what has already been spoken and I think perhaps when we consider guidelines it is a combination of the knowledge that has previously been discussed.

What's all this fuss about agricultural waste and what is government doing in the business with regulations? Let's look at some of the basics. We've had rather large production increases in the recent past. The world needs higher standards of living and so forth. Basically, we are concerned with the intensification that has taken place...efficiencies of scale which have been adopted by the producer as a necessitv of making a living and maintaining a profit of margin. There's also the rural to urban shift of man power and we must consider the cost of labour versus the cost of mechanization. There's also been an urban to rural shift in the sense of urban encroachment on traditional agricultural areas. And while we're speaking on tradition, let's for a moment consider the traditional right to comfortable enjoyment of life and property.

These words are familiar. They perhaps remind us of a definition of pollution and if I may read you one: "Pollution is a presence of one or more contaminants, in quantities or characteristics and of a duration which are injurious to human, plants or animal life or to property or which unreasonably interfere with the comfortable enjoyment of life and property." Now these suggest three words or phrases which require some consideration. First, the "contaminant", the term "unreasonable interference" and "comfortable enjoyment", are open to much conjecture and personal opinion. They involve practice of public nuisance and result quite often through the courts in a private action rather than an action brought about through some government regulation. Certain organic and inorganic substances are recognized as being undesirable, toxic even depending on their concentrations to humans. plants, and animals. Therefore, I think we must admit that the governmen or governments have a responsibility to protect the public and individuals and to limit the degree to which the contaminants are discharged.

When we consider pollution, in the past we have looked at a large percentage as being a background pollution. There is no particular point source which one can identify. Another criterion is that this type of pollution is difficult, if not impossible, to control. However, through intensification, feed lots, processing, and high fertilization of agricultural land the poultry industry and the hog operations we now recognize as point sources and through technology we have found means of controlling their effect on the air, the soil and the water.

Land disposal, from what we've heard previously, provides the least costly method of disposing of or utilizing some of these components, for example, the nitrogen, the phosphorus. We must be concerned with the criteria, we must define the criteria in relation to the effect that it is going to have on the receiving media, (air, land, water) which in turn bears a relationship to what it is going to be used for. We must be concerned with the rates and the dates in which these materials are disposed of on land and perhaps more particularly the various functions, one of the more important ones being storage which Bob was talking about earlier. These have their effects in odors, which are an indication of airborne particles which are obnoxious in large concentrations, the nitrogen, the ammonia.

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We've talked about BOD, COD, solids, dissolved and suspended, and the danger of heavy metals. We're still doing research, measuring the effects on the media in which they are received. We've recognized the factors of dispersion and dilution. We must come to grips with being able to define the tolerances in which man and animals, wildlife can survive without an appreciable damage. I think what we're alluding to is that we must have a better understanding of the ultimate use.

The methods of management vary. Vaclav was speaking of storage, the danger of overtopping. He also mentioned the run-off from feed lots, the excessive nitrogen and phosphorus which, finding their way through the surface water, cause eutrophication and the rapid decline of the life that is represented in fish kills, which also have an effect on somebody else's source of livelihood in the shell fish industry.

Turning our attention to guidelines in general....guidelines must, by nature, represent a best available practice. Practical should perhaps be added here too. The economic feasibility must be considered. They, unfortunately, cannot be workable and still be restrictive or specific. The parameters cannot be fine-honed and finite. Primarily, I think most guideline creators would take the stance that Len Webber mentioned--that we should attempt to achieve if we are speaking of rates of application, applying a quantity to a soil medium which can be readily assimilated by next year's crop and, hopefully, reduce the free pollutants to a very minimum which may find its way to the surface waters, streams and rivers and percolate downward into our groundwaters. We find in trying to put ad hoc guidelines into practice that general rules are very difficult to apply. One must consider the recipient soil from the various parameters that were mentioned earlier, percolation rates, porosities, soil structures, particle size, background chemicals. In order to derive some safe application rates for a specific field or a specific crop, it's obvious we must narrow down on a representative average, as it were, by way of these guidelines. We must, unfortunately or fortunately, not satisfy ourselves with accepting the lowest common demoninator.

Guidelines must take the form normally, of relatively simple items which allude to the more important parameters which we're basically concerned with. They deal with distances from the disposal site or storage site to other buildings and it has a relation to their use whether they are other farm buildings or whether they are housing. Application rates are dependent on slopes and crops and they appear in our guidelines. Distances from highways often appear. The times, as well as the rates of application, often find their way into guidelines. And we concern ourselves with the rate and the time lag between incorporation with the soil, Now what we're aiming for here is to tailor the predictable results as to their effect that they will have on the adjacent owners and the use of adjacent properties.

Currently in the Maritimes and, sponsored by the agricultural engineers, we are attempting to develop a set of guidelines for the disposal or utilization of agricultural wastes or by-products. Up to this time, at least on Prince Edward Island, I think it would be fair to admit that we have plagiarized largely the work that has been done in Ontario and basically been revising it to P.E.I. conditions in terms of the concentration of the waste or material we have to dispose of and the soil characteristics as opposed

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to the soils that are predominant in Ontario. We hope, within a reasonable period of time, that, collectively in the Maritime region, we will come up with a set of guidelines which will have as few as possible variations from province to province. A minimum is required, with the different physiographical characteristics, but one which, in turn, can be referred to for the different agencies in government which find themselves with one foot or the other in the door.

So, I think a comment now or some consideration must be given to the co-operative effort that must go into the development of guidelines. It varies form province to province. I think that in some provinces the Department of Agriculture is more concerned with guidelines for waste by-product utilization or disposal where, perhaps in others, conscience twigging is being done by an environmental agency. We've heard enough of the problems today to recognize that this is a role which must be played by agricultural engineers, perhaps the odd civil engineer, planners, municipal officials, producers, processors or representation from producer groups and processor groups, so that an understanding and a unified agreement can be reached which makes implementation possible.

I was going to make some comment on the federal role, the provincial role, the municipal role, and the local role, and so forth in developing this but I think at this point it is perhaps not of great importance. Suffice to say that the federal government has it's role to play, however, it is hampered by jurisdictional problems. Certainly they can make recommendations and provide expertise to the other levels of government, (you'll notice I didn't say lower levels of government), and certainly to support research in co-operation with the universities. Municipal governments in the Maritime region, tend to be small and virtually powerless. Unfortunately, in most cases where they do have problems where guidelines or regulations may come into effect, they have a vested interest. In other words, it's a source of tax income and they're much loathe to be the "heavy" which, by the process of elimination, leaves the provincial government or agencies responsible for the protection of the public. They also must carry out studies and evaluations in co-operative research with the federal government and universities.

Implementation of guidelines is a real source of problems and concern with an agency such as the one I represent. Fortunately, the majority of producers comply voluntarily and quite often exceed the recommendations made by guidelines or by the agencies responsible for guidelines or that segment which offers recommendations and assistance, such as the Department of Agriculture, Environmental Control Commission, (in P.E.I.) and the Departments of Environment in the other Maritime provinces.

However, there are a few who disregard "better practices" either through a lack of understanding of the implications of their management practices or a lack of ability to apply better management practices. One would turn to their peer groups, which have no legal jurisdiction, and quite often the effort in being a good neighbour restricts them. I think it is through the peer groups that we would hope to avoid many of the unpleasantries which take place through the process of guidelines and bringing to bear legal enforcement on those who do not comply. So it is in this vein then that I think we must turn to processor organizations to assist. It is mandatory that they be involved in the preparation of guidelines and in their implementation.

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Unfortunately, processors and many producers do not recognize waste management as a factor of production. They're being viewed as an additional cost. It has been often more desirable to overload the particular field with a high application than go to the trouble of travelling a little extra distance and go to the trouble of laying out a distribution pattern on more fields. Consequently, we have a high concentration of waste. Processors, for some reason or other, do not appear to have come to the realization that the proper disposal or utilization of their waste by-product, is an inherent role or function of their operation. Even to the rather obvious function of designing a storage area and maintaining it as a storage area, with some hope of survival in being able to utilize the material that is so-called "stored" on land for spreading as a nutrient for future crops. I know we have in our province a proliferation of little dumps which were originally intended to be "storage areas".

This, then, leaves the role for big bother. The enforcement agency must be prepared to act on behalf of the general public or for the adjacent owner of a dwelling who depends on a well for a water supply which may be increasingly contaminated through leachate from the storage area.

I think the most logical method, perhaps the most acceptable method, of implementing guidelines is, rather than rushing into restrictive legislation, to employ the approach of approvals or requests for conformance to the guidelines. We've already mentioned the necessity of tailoring these guidelines to this individual process and should non-conformance be the result then the legal authority or the policing authority, if you will, can exercise a clause in their acts or regulations which now makes it illegal for this operation to continue since they have not met the agreed disposal conditions. Then the government agency can take action.

In many instances, however, we find ourselves in a situation receiving telephone calls of complaints. Many of them, you realize, will not be handled by a government agency at public expense but would fall into the realm of a private damage which must go through the courts on a private basis. It is very difficult for an individual to collect from a corporation. We've experienced considerable problems in attempting to bring about this situation of approvals and conformance or non-conformance. We have a very simple sort of form. When someone comes to us, as our Act requires that they do for approval for disposal or method of utilization, they must fill in a form. One of the first blank spaces on the sheet of paper is the name. The next is the address. Then we ask for a simple operational plan. We'd like to know some of the quantities, for instance, of by-product that are being generated. Well now, those first two items, that is, the name and address we rarely have problems filling that out, but when we ask for a little more detail on the operational plan and what concept the processor has of the function of his waste management scheme we tend to draw blanks. It was mentioned before it's amazing how many people have no idea whatsoever of the quantity of waste they're going to generate or what's in it, for that matter. Some of them must turn to our good neighbours in the Department of Agriculture and ask them to give us information. So, jointly, then we can develop some rudiments by way of recommendations on how this plant should handle its waste.

I recall a situation that occurred quite recently. A lady, who we'll call Mrs. Nose, phoned up with a complaint from an adjacent neighbour of hers, who we'll call Mr. Hog, who has a hog operation. So, the environmental agency in question did a little research and found that the hog facility was built without a building permit and it was, I suppose 25% completed before a building permit was even applied for. No one in that agency knows how the building permit or why the building permit was finally approved but it was approved with certain conditions. One was to comply with a rule of thumb distance requirement from a property line and there was a conditional rider which required that Mr. Hog buy additional land which he never has and apparently has no intention of doing. Mrs. Nose is very concerned with the odors which are emanating from this building and the question is did Mr. Hog indicate in his application that he was intending in fact, to have hogs in this building. Well, actually he said in his application that he was intending to use this building for stock, storage of machinery, and there was some item which alluded to lawn mowing equipment which I thought was very, very good because it completely clouded the issue. Stock, of course, means livestock and hogs, apparently, are livestock. So, we have a situation now where, for some reason or another, this building permit was issued without the Department of Agriculture's knowledge. They were given no opportunity to make a comment, either as to the structure of the building or the use to which the building would be put. The planning agencies didn't recognize, or it was not evident to them, that a conflict between an urban orientated rural dweller would be faced with a change in land use. i.e. the creation of a hog barn.

Now, in many cases when an environmental agency tracks down such a complaint, and those of you who are in environmental agencies will appreciate that there are a very large number, some of them are not legitimate. They often, we find, are reduced to a local fence war or bad neighbour policy. However, some are legitimate. There is a hampering of the free enjoyment of life and property and it becomes, then, our concern as to what action should be taken.

Guidelines in their proper use with the consideration of the receiving media, I would hope, will be a means of avoiding many of these confrontations. So, I'm suggesting then, and perhaps I'm deviating from the topic I was assigned, but in an effort to emphasize that the parameters that we consider and the limitations which we impose on them must be viewed in terms of the adjacent use and the future long term use if the Maritime region, for instance, is to maintain an equilibrium and a balance of an enjoyable and desirable way of life and still retain our very important agriculture, tourism, industries and way of life.

Thank you.

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QUESTIONS ON MR. PHILLIPS' PRESENTATION

Question: (Mr. Fedoruk) Bill has indicated some guidelines to guidelines.

I'd like to start off. Len has covered it to a certain extent to this point. He said he's had to justify it in two parts of the country. The first question that always comes up are "What are the application rates?" Possibly you could go over that a little more in depth than you did this morning.

Answer: (Mr. Webber) I don't think there's much more I should add on this topic other than to re-emphasize what Mr. Phillips has said. I expect I'm labelled a conservative, that is, a small "c", and I agree with Mr. Phillips that land disposal is one thing and land utilization is another. I'm more concerned with the utilization of these wastes and application of these different wastes at levels that are not going to cause us problems in various aspects of the environment whether that is soil, or air or water. I'm not so sure I know what Mr. Phillips means when he said something to the effect of the immediacy, the immediate surroundings and so on. He may wish to clarify that but I don't think for a minute that he means waste disposal at levels that are engineeringly possible to do without concern to the environment. So, I think, I'll leave it at that point at the present time, but I just want to make a point we must distinguish between disposal and utilization. There's quite a difference. If you want to dispose of it you do like the farmer in New Jersey. He went and got the tractor and the honeywagon and the injector from the state college and they told him to fill it up and start at the top of your hill and come down. Well, he did that a time or two and about the third time coming down most of the hillside came down with him. Now that's disposal. That's a little more than utilization.

Comment: (Mr. Kumbhare) I'd like to make a comment with regards to the land use in relation to waste disposal and it appears to me that it is very important to first establish what the land use requirements will be. That implies inter-agency co-operation, public involvement to establish a long range plan for land utilization.

Question: (Mr. Fedoruk) What he was saying is that we try to apply the best practicable technology. What is the best practicable technology?

Answer: (Mr. Phillips) One of the things that we all hear is that after a recommendation has been made or a recommendation in conversation is discussed, well, that's not practical. Now, this is a question that I ask my colleagues and myself many, many times--What is practicable? A few years ago many of the essentials, the items that we consider essential today, were luxuries and not practical. We're rather closely knit to the problems of Prince Edward Island. Our population distribution gives us fits over the ramifications of waste management. There are very few places where we can go and let it loose as it were. I think an example which does not apply directly here is the disposal of oil and oil contaminated materials from oil spills off shore or otherwise and it is extremely difficult

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to locate an area where one can safely dispose of wastes, let's say, by the sanitary landfill disposal method. So, we're looking at technology in the form of a sophisticated incineration process which takes oil contaminated wastes in one end, which is an atrocious mess, and spits out rocks and soil and sand and what not at the other end. Whether or not that would be economically feasible, bearing in mind the odds of frequency of such an occurence, we don't think so. When you consider this in terms of leachate from a peel waste, its going to leak quite rapidly. A large quantity of leachate is going to come out over an initial period of time and then it will slow down and that's fine if you're out in the boondocks somewhere but if you've got a well a quarter of a mile away, you're going to contaminate it. So, we feel then that we have to first of all in a form, in an application form, very specifically state that the person who is disposing this material is ultimately responsible for any damages and we would advise such things as an impermeable, compacted layer preferably confined to clay. But the processor will scream that this is an unnecessary cost. So, I'd hope that somebody else would put a line of demarcation between practical and impractical.

Question: (Mr. Fedoruk) George Lindsay, you were involved in some guideline development. What were the points discussed?

Answer: (Mr. G. Lindsay, Environmental Protection Service, Environment Canada, Halifax, Nova Scotia) Regarding technology itself the usual acceptance, first of all, for incorporation in guidelines is that the technology is in fact usable and at the same time does not create or impose undue economic restrictions. There are technologies available for by-product recovery.

Comment: (Unidentified) First, I'd like to comment on the statement made by Mr. Kresta to the effect that this assimilation of wastes in water is quite well known and it's been my personal experience over the last year or two that there is quite a field technology in this area which is not known at all. For example, there doesn't seem to be anyone working in the area using waste materials or excess materials from food processing to fertilize our coastal waters. It has been done more or less accidentally over the years and there's some indication that it has been beneficial. The industry in general is now being asked to stop doing this and to solve certain problem areas. But, there seems to be quite a bit of work that could be done in this area and should be done in this area as soon as possible. Otherwise, we'll be wasting some of the resources that we have. Certainly I'd like to ask Mr. Kresta a question and from what he says today it seems obvious that he's very familiar with the situation in the industry. Supposing the use of 25 mesh tangential screens becomes widespread in the fish processing industry and supposing that it becomes widespread in some of these small plants that he's mentioned which are presently disposing of their wastes in landfill operations...I was just wondering what his opinion would be as to whether or not this is the best approach or should it be disposed of at sea? Supplementary to that, some of us can foresee quite a problem in using the material that is removed from tangential screens in conventional fish meal plants. Would he personally favour disposal on land or disposal at sea?

Answer: (Mr. Kresta) You prefer to know my personal opinion or the official opinion? Now, I better start with the official opinion. We are representatives of all the people living in the Maritimes and we have to abide to the rules and have to follow what is stated in the law and in this particular situation in the Fisheries Act. Now, I must agree with you, and I think it's common knowledge that in many cases we do not know exactly how far we can go. But, we know from experience that there are areas where the simple fact that the industry was allowed to discharge, without too much concern, their wastes into the environment they have simply spoiled everything around the fish plant. I can tell you that we have areas in New Brunswick where it's simply almost unbearable to stand on the wharf and see what is happening in the wharf enclosure where the wastes are being discharged and to breathe the air in those areas when the fish plants do operate. On the other hand, for sure, we have areas where there is a single plant on the shore and it discharges to waters where there is a good mixing, where there is a good movement of water, and then you can expect that fish will be extremely happy to have something to feed on. Now this is the problem with all guidelines, because in the guidelines you simply cannot state individual cases. Now it's my personal opinion that we, as the representatives of the government, should use common sense and request the treatment according to the environmental situation in the particular area. It's extremely difficult to put this in guidelines. Now, we have cases where a fish plant operates or is considering operating where the fish processor does not know how much water he will use, how much fish he will process. It varies throughout the year and varies from year to year. How would you expect from us to use this common sense and say "This year it should be o.k. but next year you will create problems". For that reason, you must understand why the requirement is here to remove the solids as much as possible. Once again it's my personal opinion that in this particular case the fish processing industry will find out that there's a good money turnover in having the fine screen. I have said in my presentation that the fish processors are really surprised at how much solids they do recover. They were not aware because if you look at the stream which is flowing at say, 100 gallons per minute or something like that, you can see a few solids going away. But, only if the whole daily production is passed through a screen suddenly they have been full of offal. I agree with you that it can cause some problems in the rendering plants but there is a technology to develop and perhaps this can force the rendering plants to operate in such a way that they can cope with the higher liquid content in the offal. It's different from what they are processing now, I agree.

Now back to the first comment. I haven't said in my presentation that everything is known about the estuary. I only stated, if I did follow the literature, that you can find a lot of studies about estuaries, about assimilation capacity of streams, but much less is known about how much you can put on soil and if you find something it's very certain that you will find quite different opinions.

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Question: (Unidentified) The economic aspects of recovering wastes varied so much with the particular type of fish. In some cases screening recovers something that can be used; in others it recovers very little. Do you favour land disposal or sea disposal?

Answer: (Mr. Kresta) I think that there is nothing wrong with land disposal because Indians have used fish as a fertilizer for centuries. Now, I don't know whether it's really economical to do that. This is one thing. Concerning the screening, I think that the need to have as many feed ingredients as possible would force us to utilize as much as we can and as much as we can economically. Now, I've seen schools of fish which feed on the solids discharged with wastes. Now, it would be my very personal opinion that where this can be done without causing damage to the environment there is nothing wrong with that. But, as I'm saying it's my very own personal opinion.

If you have a very flat beach area you simply cannot afford to discharge the solids in that section. If the plant is located at the wharf where you have significant depth of water you can, or you could.

Comment: (Mr. Phillips) Well, for what it's worth, our biologist seemed to feel that as far as discharge at sea is concerned, there is virtually nothing wrong with it, depending on the tides, the current and what not. This is a source of food for the lobster and the estuary crustacean. Where it becomes objectional is when the tide washes it up on a recreational beach. I think what all this boils down to is that you have to measure the adequacy of the method by it's effect. If it wrecks recreational beaches it's an no-no but if it can avoid this and be a source of food in the ecological chain, fine. And this, I guess, is really why the requirements under the Act leaves broad leeway for interpretation.

Comment: (Unidentified) Purpose of my question was because the industry might be forced to make this decision, in some cases very soon, are we going to take this to the land or are we going to take it back to sea where it was headed in the first place?

Comment: (Mr. Kresta) There is one more fact which I didn't want to bring up. Perhaps you, as a representative of industry, could comment on that. We have a lot of problems arising from the simple fact that one processor is asked to install fine screens and the other, perhaps because he is in a more favourable locality where the problems are not so serious would not be asked. Now, that guy who is in the bad locality asks "Why me?" if the other guy is not forced to do that. How do you answer that? He won't understand it's not necessary because of ecological reasons. He would state "O.K., but this increases my cost of production", and he is right. On the other hand, if we force it on the other guy, it increases his cost of production, perhaps unnecessarily from the total point of view of the environment, but if we don't do that with the other guy the first guy won't do it either.

Comment: (Unidentified) I noted the other day that certain problems in the Maritimes are common to Newfoundland. The City of St. John's is serviced by what is known as a sanitary landfill. Actually, it is an area landfill site where the garbage is thrown down and covered with soil. This has operated for about 20 years and right now we're running out of fill and I think the last study down there estimated about two years left and then they would have to move. So the government commissioned a study by consulting engineers and they decided that they would locate a regional dumping area which would take care of all the garbage from St. John's plus all the fringe areas. This study took about a year and finally they put forth a recommendation. They selected an area outside St. John's and immediately all Hell broke loose. People in the small communities said "Why should St. John's bring their garbage out here and dump it on our lands". Right now the Minister has had no success at all in convincing those people that the new site will be using a better method. The government is avoiding the responsibility by saying the communities can look after their own dumps if they want to. Some people don't seem to understand what is involved when new methods are used.

Comment: (Mr. Webber) I'm going to get into a field which I know nothing about and that is the disposal of wastes and so on from fish plants. I admit that I don't know anything about it and my comments will probably display that ignorance. But, I was under the impression, Mr. Kresta, that the coastal waters are adequately fertilized as they are. They may not be. If I were a fish operator, plant operator, I think that is what I'd look to. If you permit them to dump wastes into the coastal waters then I as a processor of poultry, livestock, I would expect the same privilege. If I were involved with a municipality having difficulty getting rid of sewage sludges and so on then I would expect the same privilege to dump the wastes into the sea. The question I ask you is "Where are you going to stop?" I think that if you open the door for one you must open the door for everybody and maybe I'm idealistic here, I don't know. In this connection we can tie in the other remark that we heard over here earlier, something about land use. What are we doing about land use? Where are we going with it? And so on. But, I'm just afraid that in the part of Canada that I come from, west of here, that we are inclined to hide behind that lovely term "land use and land use planning". It covers up a lot of ignorance on our part. As of yesterday morning I'm not aware of any rigid, realistic, enforceable land use plan for Ontario. Land use planning comes in so intimately when you talk about waste disposal and that type of thing. I think that we've got to separate a lot of the essentials here from some of these mythical or idealistic terms of which we talk and land use is one of them. I also think in connection with disposal in coastal waters, and again I don't know anything about it, that it is analogous in some respects maybe to what we have in Ontario where the environmental protection boys seem to be wearing two hats maybe three hats. If they're talking about a pulp and paper mill in northern Ontario or on the north shore of Lake Superior, there is quite a different code of water quality standards applying to that mill to what there is in southern Ontario. The operators, I am told, in some northern mills can have more leeway than what a mill

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in southern Ontario would have. So, maybe Mr. Kresta, we come back to what you said and what Mr. Lindsay said. It has to be practical. It has to be commercial. I think the technology for most of these waste disposal methods is generally available but it is probably a cost operation. Thank you.

Comment: (Mr. Kresta) I have to agree with you quite heartily and instead of answering, because I don't have the answers, I would add one more aspect. You will remember in the past decades there has been a lot of discussion whether to use or not to use the assimilative capacity of streams. There are people in our field who advocate reasonable use of the assimilative capacity. There are people who simply say "No, we should do what is possible with the available and practicable technology and leave for the streams only that portion which can not be removed by the technology we do have". And, that's a very similar situation as land use. You can, depending on the stream, have a very large industry which will not influence or have little influence on the quality of the stream and you can have the same plant on a small stream and everything is bad. Now, from the ecological point of view the practicable, economical technology is something quite different in both cases.

Comment: (Mr. Phillips) It seems that the agency involved has a responsibility to a processing industry discharging into a stream, where over about twenty miles, whatever, is discharged, the pollutants have naturally been reduced such that in this twenty miles they are not measurable. So, you say, "O.K., plant X you're laughing. You don't have to put in this sophisticated pollution abatement facility." I think that there is a responsibility to say that you don't have to do it for at least five years or such and such because we don't anticipate any encroachment within that twenty mile fringe. Now, plant Y sets up adjacent to it. It wants the same discharge. Well, you've used up the assimilative capacity for that twenty miles. So, what sort of restrictions are you going to put on plant Y? Now, does plant X have to reduce emissions to accommodate the effluents from the additional plant? And, what happens when the area has not been adequately protected or one has not been able to foresee a use that the public demands for that which brings it into an urban development, or a recreational development. What was once an acceptable level is now no longer acceptable. We all, I agree, hide behind the thing because it's an easy out. We are not able to make these predictions. I think we have to start somewhere. Before, I was alluding to a study that took place in an area of Prince Edward Island, where a rather large acreage was envisioned as a park and it was in agriculture, not particularly intensive. For instance, there was very little in the way of livestock or hog production. It was basically in potatoes and hay. No intensive livestock. Well, hog operations came into being while the study was going on. So, one of the recommendations that came out of this thing was extremely controversial. It turned up because it suggested that hog manure should not be spread in certain periods of the year which included the nice, hot month of August because it interfered with the tourist enjoyment of this area. In all due respect to the hog operators odors from hog operations have a lasting effect. They seem to permeate a vehicle that drives through the area. After you've left the hog farm several miles behind you still have the odor in your car. If you've invested in a motel or private cottage you do tend to get just a little up tight about some guy spreading on a field in August. So, the recommendation was made and we thought that it had got on that high shelf that Don Gunn was talking about but somebody pulled it down not too long ago and a producer group got quite upset about it.

Finally, I want to say there is one factor that nobody has brought up here yet and I noticed that very recently that either Manitoba or Alberta has instituted a relocation grant which can be applied to an industry which has become incompatable in the area in which it exists. This is a grant which is given by governments. I think in the Maritime region there is some source that can be tapped, be it the Department of Industry or Agriculture or whatever for relocation when it becomes impractical, even considering available technology, to reduce the undesirable characteristics of the effluent. The plant has to move but it doesn't have to do it solely on their own financial devices. It can get assistance from government.

Comment: (Mr. Fedoruk) Are there any more questions? If not, I'd like to thank the four speakers. The topics covered today were done in a lot of depth. A lot of material has been brought forward. I've learned a lot. Some of it went over my head. Some of it I understood quite well. I'm very pleased that so many people could make it.

Thank you.

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