CHOOSING BETWEEN AGRICULTURAL LAND APPLICATION AND LANDFILLING OR INCINERATION OF MUNICIPAL WASTEWATER BIOSOLIDS

by

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ABSTRACT

The treatment of municipal wastewater generates residues as a by-product of its processes. Residual biosolids have previously been viewed as liabilities of the treatment process. Currently, however, biosolids are increasingly being put to beneficial reuse as agricultural fertilizer and soil conditioners.

This paper tabulates the reasons for the change from disposal methods such as incineration and landfilling to recycling. The reasons for choosing between these methods are analyzed through the use of survey responses from municipal wastewater treatment facility managers. The implications of a change from residue disposal to biosolids reuse are also discussed. The effects of these changes on the wastewater treatment processes utilized, and subsequent management practices are examined.

The findings of the study show, that although agricultural land application of municipal wastewater biosolids is ecologically the most beneficial method of disposal, the major consideration in its use is cost. The benefits of land application are used primarily as sales tools to promote the program, however bad public relations, and negative public response have the potential to completely squash a program. The resultant conclusion is, that if costs were relatively equal, landfilling or incineration would be used in spite of the ecological benefits of land application.

PERSONAL VITA

Jeanette M. Best is a life long resident of Saginaw, Michigan. She received her Bachelor of Science Degree in Geology from the University of Michigan, Ann Arbor in 1973. She is currently a candidate for a Master of Public Administration degree from the University of Michigan-Flint and the Horace Rackham Graduate School.

Jeanette has worked in the wastewater treatment field for nearly 20 years, progressing from laboratory technician to Chief Chemist at the City of Saginaw Wastewater Treatment Plant, Operations Technician at General Motors' Saginaw Division, to her current position as Assistant Superintendent of Genesee County Division of Water and Waste Services' Anthony Ragnone Wastewater Treatment Plant.

Jeanette is an active member and Past President of the Michigan Water Environment Association (MWEA). She currently chairs the MWEA Ad Hoc Biosolids Committee which is in the process of working with the Michigan Department of Natural Resources to develop a new program for agricultural land application of municipal biosolids in Michigan.

Jeanette is the recipient of the MWEA's Outstanding Wastewater Worker of the Year Award, Industrial Division (1985), and two MWEA Service Awards. In June 1994, she will receive the Water Environment Federation's Bedell Award for service to the Michigan Association and promotion of water quality programs.

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I dedicate this endeavor to my husband, Jonathan, who believed in me even when I failed to believe in myself.

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CHAPTER 1

INTRODUCTION

Are changes in the method of choice for disposal of wastewater biosolids the result of pure cost effectiveness, or are there other factors that have driven municipalities from landfilling to agricultural land application? Many methods for disposal of municipal wastewater sludges have been followed since the enactment of the Clean Water Act of 1972. The disposal solution for large wastewater treatment facilities has gone from incineration to landfilling, and now appears to be shifting to agricultural land application[1].

The purpose of this study is to examine reasons for change in disposal methods of wastewater residues. A cost benefit analysis is compared to a cost effectiveness evaluation of the alternate methods. The study is based on survey responses from municipal wastewater treatment facility managers expressing their individual reasons for changing methods of disposal.

Since changes in biosolids disposal methods may require altered management practices, a detailed discussion of the implications of such changes, and cost and effect on other wastewater programs managed at these facilities is provided.

To develop the basis for this study a background summary of wastewater treatment is provided in this chapter. A review of current literature is also compiled to provide insight into the issues relative to the disposal of wastewater residues. This information will lay the foundation for the theory and hypothesis of this study: Do most wastewater treatment plants use agricultural land application for disposal of biosolids primarily because of cost considerations alone or are the other external benefits of recycling nutrients back into the soil and reduced use of landfills considered?

BACKGROUND

In Michigan, wastewater treatment plants or Publicly Owned Treatment Works (POTW's), range in size from those treating a few thousand gallons to those treating millions of gallons of sewage a day. The Detroit plant, for example, treats nearly one billion gallons of water daily[2]. The plants range in complexity from those which let natural organisms metabolize wastes gradually in large ponds or lagoons to those which artificially speed up this process through very sophisticated mechanical and chemical means (Water Pollution Control Federation 1990).

The Michigan Department of Natural Resources classifies treatment facilities by size and process complexity. Lagoons are classed "L", the smallest treatment plants are classed "D",

while the largest are classed "A". Those in between are Classes "C" and "B". Michigan has only 27 Class A wastewater treatment plants, and only half process flows greater than 10 million gallons per day.

Part of the wastewater treatment process is the removal of solid materials from the water. The solids or sludges are collected during an initial settling process where the water is allowed a quiescent period. Other organic solids result from microorganisms metabolizing particulate and soluble nutrients from the sewage. These microorganisms are then removed from the water in the final stages of treatment and then become additional "biosolids". The last step of treatment is recycling or the return of disinfected clean water to nature. At this stage the removed solids must also be disposed of or recycled (California State University 1980).

Disposal methods for wastewater residues include incineration, landfilling and agricultural land application. A brief description of each of method follows.

Incineration of solids is the burning of dewatered solids by means of multiple hearth furnaces. When residues are removed from the wastewater process they are only 2 to 12 percent solid material. The residues are then chemically treated to enhance coagulation and separation from the entrained water. The resultant sludge is then mechanically dewatered using either huge filters, centrifuges, or specially designed

thickening tanks. This dewatered material is fed into the gas fired furnace. Upon completion of the combustion, the ash is removed from the furnace by mechanical means, slurried with water and pumped to large holding ponds. When the pond becomes full it is dredged and the ash is taken to a landfill.

Landfilling of solids eliminates the gas fired incinerator. However the same steps for biosolids removal and dewatering must be taken. After the residues are dewatered, they are then loaded into trucks and transported to sanitary landfills. Fees for dumping the solids, called tipping fees, add costs to this disposal method above the trucking charges.

Agricultural land application of biosolids requires that solids removed from the wastewater treatment process be stored in large tanks until transportation to the field. In most cases solids do not require dewatering before application to a farmer's field. The application of liquid biosolids does require that the solids be treated for pathogen reduction before being used as fertilizer. The biosolids are then transported to the agricultural land where they are subsurface injected into the soil by a specially designed applicator. In other instances dewatered biosolids are spread on top of the ground and then incorporated by the farmer into the soil (Water Pollution Control Federation 1990).

In Michigan land application of biosolids requires large storage facilities for liquid sludge or the use of an alternate disposal method during the winter months when the soil is frozen. Because the biosolids are used as nutrients for farm crops, they must be applied to a field either before the crop is planted or after it is harvested, preparing the field for a new crop.

LITERATURE REVIEW

The completion of background information for this study must include a survey of the issues discussed in the current literature surrounding land application of municipal wastewater biosolids. Cost effectiveness is used as a tool rather than cost analysis because the output effects of land application are nominally unquantifiable due to the range in size of programs undertaken by various wastewater treatment plants (Nas 1992). It does allow comparison of the desired outcome of solids disposal to the overall cost of a program including capital and labor costs. The cost benefit analysis is used so that the social benefits and externalities of a land application program might be considered in the selection of a biosolids disposal program.

The benefits of a recycling program for biosolids are that it supplies trace minerals, nitrogen, phosphorus, and, through increased crop yield, organic material (Logsdow 1993).

It typically supplies the farmer with $30-$60 worth of nitrogen per ton (Beard 1993). While land application of biosolids does not completely replace fertilizers, it reduces the cost to the farmer for fertilizer. In Genesee County, Michigan the average fertilizer cost savings per acre was $38.68 (Kilpinski 1993).

Is this resource, in fact, too valuable to waste? Third world countries suffer hunger, while developed countries routinely dispose of these biosolid resources by landfilling, incineration, and ocean dumping[3]. These products could be used by third world countries to improve infertile soils without destruction of soil, surface water, or groundwater. Industrial nations should take the lead in recycling all waste products (Nicholson 1991).

The state of the art Los Angeles Hyperion Wastewater Treatment Plant responded to the recent ban on ocean dumping by developing various programs for reuse of its biosolids. "The implementation of similar alternatives should be the goal of today's utilities because the environment is too precious for the unnecessary disposal of a valuable resource" (Harrison 1991).

However, developing markets for the beneficial reuse of biosolids will be a concern for for more and more municipalities. Evaluating future demand will be difficult because biosolids production is not driven by a market demand. Availability will increase as more municipalities look for

acceptable recycling disposal methods. Competition for market share could become critical until biosolids producers overcome the negative public relations issue surrounding biosolids reuse (Austin 1992).

The largest single roadblock in recycling biosolids is public perception. One disgruntled user of a solids reuse program accused it of sloppy management and blamed decreased yield and increased disease in his dairy herd on the biosolids (Hagg 1992). Such claims are hard to verify and are equally difficult to refute. The author of one article, Alan B. Nichols, concludes that acceptance will come ". . . only when sludge becomes a valuable resource and a marketable product rather than a waste product" (Nichols 1992).

In Michigan the Michigan Department of Natural Resources (MDNR) oversees the agricultural land application of biosolids. The reason for such oversight is to assure farmers using the program that biosolids are applied in agronomically-based amounts, providing nutrients that the crop will use and no more. This protects surface waters from runoff, and groundwater from migrating contamination. When such safeguards are in place and supervised by the MDNR, the farmer is assured that he is participating in a safe and worthwhile program (Peterson 1993).

The benefits of biosolids use, from a farmer's perspective, include increased organic matter, essential plant nutrients, and increased plant vigor and yield (Wegner 1993).

Mr. Wegner, a farmer himself, concludes that not only the farmers using biosolids reap the benefits, but the nation as a whole benefits from increased production and recycling of this valuable byproduct.

SUCCEEDING CHAPTER ORGANIZATION

Chapter 2 introduces the theory and hypothesis of this study.

Chapter 3 presents the methodology used to perform the investigation. Additional methods of supplying information necessary to support the hypothesis are also presented here.

Chapter 4 examines the cost benefit analysis of agricultural land application of municipal biosolids. This analysis shows that the decision to land apply biosolids could be justified on the basis of cost benefit analysis.

In Chapter 5 the survey results are tabulated and evaluated. From the survey results, conclusions can be drawn with respect to the hypothesis. These conclusions are the primary component of Chapter 6 which will also include possible implications of the findings and their effect on the future of wastewater treatment in Michigan.

CHAPTER 2

THEORY AND HYPOTHESIS

The key to wastewater treatment is removal of the "waste" from the "water." Treatment technology has made tremendous advances over the years but one factor has remained the same. Residues, or biosolids as they are now called, remain for disposal after the treated water is returned to the environment. The removal and disposal or reuse of these solids is a key part of wastewater treatment.

Various methods of biosolids disposal have existed for as long as wastewater treatment plants have been built (Water Pollution Control Federation 1990). However the methods used by various sized POTW's in Michigan have changed over the past 25 years[4]. The evolution has been strictly economical rather than ecological. The progression in large wastewater treatment plants from gas fired incineration to landfilling of biosolids was a direct result of increasing gas and oil prices in the mid 1970's. Landfill space was then plentiful and cheap[5].

The current trend for disposal of biosolids is toward beneficial reuse of the solids as fertilizers and soil conditioners on agricultural land (Harrison and Crosse 1991; Hasbach 1991). Application of biosolids is once again the most cost effective method of disposal due to rapidly rising costs as landfill space becomes scarce.

A permit for the construction of a sanitary landfill, written by the Michigan Department of Natural Resources Waste Management Division, requires over two years lead time before its issuance[6]. State regulations are currently restricting or banning recyclable materials from disposal in landfills. The first step in this process is the elimination of yard wastes and grass clippings. Tipping fees, those fees charged to use the landfill, are increasing yearly as landfills struggle to keep pace with with demand for more space[7].

The largest single drawback to agricultural land application for biosolids reuse/disposal is in public relations. The general public does not understand the process and in many cases fears it. Many people feel that the procedure is acceptable only if it is "not in my back yard".

The media has immersed the public in horror stories of groundwater and soil contamination by unscrupulous industries, of mismanaged municipal dumps and landfills, and of pollution disasters world wide. One of the more memorable local examples is the Berlin and Ferro landfill just outside Flint, Michigan, where hazardous waste was found to have been disposed of improperly and toxic waste products contaminated both soil and water for miles around. Other infamous disasters include the Exxon Valdez oil spill and the catastrophe of Bhopal, India where thousands of innocent victims were killed[8].

Educating the public about agronomically-sound agricultural land application of municipal biosolids can be expensive and difficult (Beard 1993). Landfilling or incinerating the residues does not share this public relations problem. This is the single largest benefit on the side for landfilling and incineration of wastewater treatment solids.

Do most wastewater treatment plants use agricultural land application for disposal of biosolids primarily because of cost considerations? Or, is the cost benefit analysis of agricultural land application versus landfilling or incineration of wastewater biosolids considered by Publicly Owned Treatment Works (POTW's) even if it is not the primary decision tool?

What role do the secondary benefits of reuse of biosolids and their positive impact on the environment have on a municipality's decision to use the land application method? Are the externalities of recycling vital nutrients back into agricultural soils, which in turn saves the farmer money by supplying a portion of his crop's fertilizer needs, a consideration at all? These are the questions answered by this study.

CHAPTER 3

METHODOLOGY

To substantiate the hypothesis that the decision to use agricultural land application as a means of biosolids disposal by municipal wastewater treatment facilities is primarily a cost effectiveness decision, large Michigan Class A POTW's were surveyed. The decision to use large Michigan Class A treatment plants was made due to the size of their solids disposal programs. Cost effects of program changes are most apparent in a large facility with significant solids disposal requirements. The disadvantages of land application are also more obvious in a sizable program. Larger disposal programs require more acreage to recycle their solids than the smaller POTW with a smaller volume of biosolids to land apply. In fact some small plants may only require 10 acres or less, while bigger plants require as many as 15,000 acres (Biosolids Survey 1993).

The restrictions of land application, (ie., to apply biosolids between farmers' harvesting and planting schedules, and when the weather is warm enough for soils to be frost free and dry) are most pronounced with a large program. A few small wastewater treatment plants were also asked to complete the survey so that the perspective of a small program could be compared to that of the larger plants. A list of the plants contacted is given in Appendix 1.

The survey was developed to assess the factors leading to a decision to change the biosolids disposal method used by the wastewater treatment plant. Appendix 2 contains a copy of the survey. The survey begins by collecting data concerning the past solids disposal practices of a POTW, and includes cost data on the alternate method used. Questions two and three ask specifically for the reason a wastewater treatment plant manager changed from an alternate disposal practice to land application. The survey asks for a ranking on a scale of 1-5 of cost as a decision factor for the change. Questions 4 through 7 ask specific questions about the size of the POTW's land application program and the amount of farm land required to support the program. The last four questions in the survey ask for personal observations from the plant manager concerning the pros and cons of the land application program compared to an alternate solids management program.

Information gathered from this survey will allow the determination of the cost effectiveness of land application versus landfilling or incineration of biosolids from the perspective of several Michigan POTW's which have recently changed their methods of residue disposal. Cost comparisons of landfilling sludge versus land applying it for agricultural use will be provided by each respondent. The survey gathers information by cost comparison and personal comment to evaluate the impact of cost effectiveness on the change from one method of disposal to another.

As noted in the background information of this study there are only 27 Class A POTW's in Michigan. Half of the Class A plants have daily flows greater than 10 million gallons per day which indicates that most of Michigan WWTP's are relatively small facilities. Not all of the large facilities currently use land application of biosolids as their method for solids management. This will leave a rather small sample for the study. However, the information gathered will be representative of a population of wastewater treatment plants in Michigan which has changed solids disposal methods. Informal personal interviews with facility managers of POTW's not completing surveys, will assist in evaluating the data gathered. (See note 1 for a list of those interviewed.)

CHAPTER 4

COST BENEFIT ANALYSIS OF BIOSOLIDS LAND APPLICATION

For the purpose of this analysis, the project output is defined as disposal of wastewater treatment biosolids. The removal and disposal of residues is critical to wastewater treatment. Residues, or biosolids, are the remaining solid materials removed from sewage in the treatment process. They consist mainly of organic materials, nutrients including phosphorus and ammonia, and small amounts of fine grit or sand.

The targeted population for the analysis is Michigan Municipal wastewater treatment plants. An alternate population which might be considered is the farmers of Michigan who receive the benefits of the land application program as fertilizer supplements and cost savings directly. A third population which could be considered for a cost benefit analysis of biosolids land application is the citizens who reside near an application site. For these individuals, benefits could be considered negative, as compared to the population in general, due to increased truck traffic in their neighborhoods during the application, and the possibility of encountering some temporary odor from the biosolids.

Neither of these alternate populations, however, is affected by the defined project output of biosolids disposal. Both experience some negative and some positive benefits, but the disposal of wastewater residues is not a primary concern of either group. Their concern for biosolids disposal is only secondary, in that alternate disposal methods may cost more which would translate into higher sewer use rates to them as consumers.

Issues to be considered in this section of the study are the treatment of wastewater, which is mandated by the Clean Water Act of 1972, and the responsible disposal or utilization of byproducts of that treatment process. Wastewater residues contain nutrients that can be safely recycled back into the environment.

Table 1 (which outlines the costs and benefits of land application of biosolids compared to a status quo of solids disposal by landfilling or incineration) shows that all methods meet the project goal of solids removal from the wastewater treatment plant. All methods can be termed environmentally sound (Water Pollution Control Federation 1990). Benefits of agricultural land application not shared by the status quo, are the preservation of landfill space, the externalities of fertilizer cost savings to farmers, and increased crop yields which could produce lower priced consumer food products[9] (Wegner 1993). Land application also recycles a waste product turning it into an asset rather than a liability.

COSTS AND BENEFITS OF SOLIDS DISPOSAL PROGRAMS

STATUS QUO

LANDFILLING OR INCINERATION

COSTS	BENEFITS
Dollar Cost for Removal	Biosolids Disposal
Cost of Landfill Space	Environmentally Sound Practice
No Beneficial Use of Solids	
Requires Extra Solids Treatment	
Truck Traffic To & From the Plant	
Energy	

LAND APPLICATION

COSTS	BENEFITS
Dollar Cost for Removal	Biosolids Disposal
Construction Costs for Storage	Saves Landfill Space
Truck Traffic To & From Plant	Recycles a Waste Product
Indirect Costs	Environmentally Sound Practice
Odor Problems	Externalities
Public Education	Nutrients for Crops
Negative Media	Fertilizer Cost Reduction
Stricter Regulation	

TABLE 1

Looking at the status quo, landfilling or incineration of residues, the survey provides a cost average for the municipalities at $130.91 per dry ton. Added to the costs are the use of available landfill space for disposal or the use of energy to fire an incinerator. This creates a scarcity of landfill space or energy and may contribute to price increases in both cases. Additional costs are extra treatment requirements which necessitate additional manpower, maintenance, and equipment. Truck traffic to and from the treatment plant and a disposal site is common to both landfilling and land application. Exhaust emissions and potential air pollution from the incinerators is unique to this method of disposal. Risk analyses performed in the development of Federal Regulation 503 (sludge regulations) showed that the health risk was significantly higher for incineration than for either agricultural land application or landfilling (Kowal 1985).

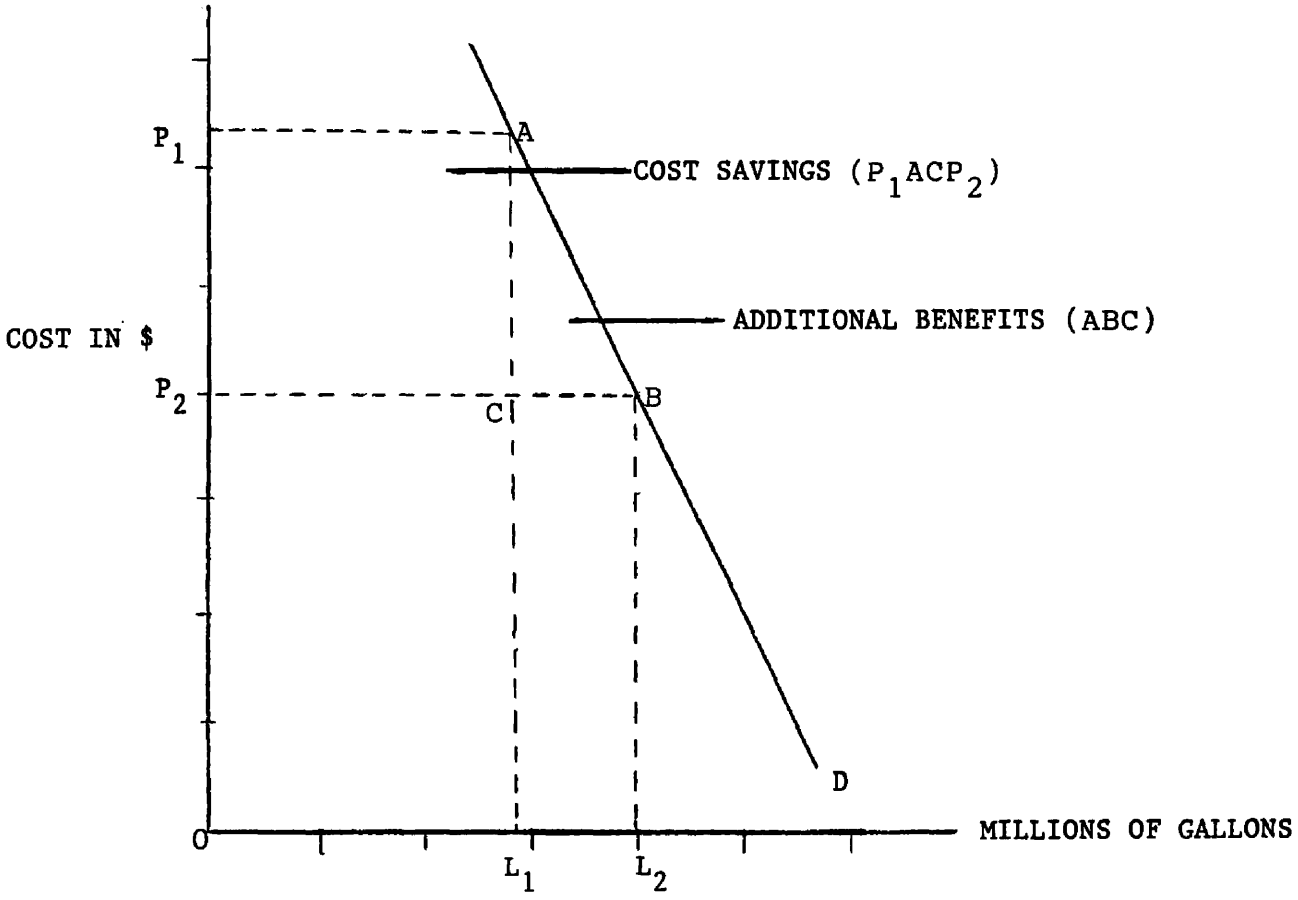
On the benefit side for the status quo, the objective of solids removal is met. Both landfilling and incineration are environmentally sound disposal techniques. There are few negative benefits to the population in general other than the increased costs of some resources. Those living near landfills are no more adversely affected by solids disposal than they are by normal trash disposal and, therefore, any negative benefits of living near a landfill can not be attributed to the landfilling of wastewater treatment residues.

The evaluation of agricultural land application of municipal biosolids shows that the average disposal cost in Michigan (from the survey) is $79.36 per dry ton of solids. This is significantly lower than the $130.90 cost average per dry ton of solids for alternate methods. (See graph 1.)

Graph 1 describes the cost benefit of land application over alternate disposal methods. The horizontal axis (X-axis) represents the millions of gallons of liquid sludge disposal. The vertical axis (Y-axis) represents the cost in dollars of disposal. D represents the demand for solids removal at wastewater treatment facilities. P_1 is the price of the alternate method's level of disposal, L_1. P_2 is the price paid for disposal of a level, L_2, million gallons of biosolids by the land application method.

The dollar savings for using the land application method over an alternate method is represented by the area P_1ACP_2. The additional benefits of land application, eg. value to farmers, recycling of a byproduct, and conservation of landfill space for alternate uses, is shown by the area ABC.

There are additional factors, however, which must be considered concerning costs which are not immediately obvious for land application which is significantly different than the status quo, therefore, requiring specialized equipment which most wastewater treatment plants do not have at the time the decision is made to change from an alternate method.



BIOSOLIDS DISPOSAL

D = Demand
L_1, L_2 = Levels of production (disposal)

P_1, P_2 = Prices of production (disposal)

GRAPH: 1

Land application requires the construction of facilities to store the biosolids when agricultural land is not available due to farming schedules or to Michigan weather. For example, a ten million gallon storage tank constructed for the Genesee County Ragnone Wastewater Treatment Plant in 1986 cost approximately $3.5 million dollars. Using the Environmental Protection Agency's (EPA) guideline for a 20 year amortization, the cost of the storage tank to the land application program at Genesee County amounts to an additional yearly cost of $175,000. Original construction of wastewater treatment facilities included the necessary equipment for landfilling and incineration, and in most cases since there were federal dollars provided by the Construction Grants Program of the Clean Water Act there was little adverse monetary impact.

Looking at the indirect costs of land application, the first consideration is its seasonal nature. It is weather dependent; frozen or wet ground is unsuitable for application. The deposition of biosolids must also fit into a farmers crop production schedule. New practices of "no till"[10] farming completely eliminate the possibility of biosolids injection, and current Michigan Department of Natural Resources (MDNR) regulations prohibit surface spreading of solids. This limits the agricultural land available. Landfilling and incineration are not governed by such restrictions.

Public acceptance of agricultural land application is difficult to gain and can be the most costly in terms of whether or not the program will work. Education of the public and the news media is a necessity. Stories of pollution disaster make better news than recycling of wastewater biosolids as agricultural nutrients. A rapport with local news staff people must be cultured and those working for the municipality must learn to address questions from the media in clear concise terms. Promotion of the program is crucial.

Another cost consideration is odors, which are difficult to mitigate and may affect those close to an application site. Although the odors are transient and last only a day or two, their effect on the neighbors can be significant (Rubenstein 1994). The last cost to be considered for agricultural land application is that of state and federal regulations, which require more testing and closer management than does landfilling or incineration. Many of the MDNR's policies are in fact a hindrance to the program[11].

To look at the benefit side of agricultural land application of municipal biosolids, there are two obvious facts: it removes the residues from the wastewater treatment plant, which is the desired output of this analysis, and it saves landfill space at the same time. An external benefit of saving landfill space is that it may keep costs down by reducing demand for this scarce resource.

Another benefit of land application is the recycling of a waste product. The externalities of this are nutrients provided to crops, including micronutrients, which when using chemical fertilizers must be added separately, better crop yields for farmers, cost savings for farmers buying fertilizers (ie., substituting biosolids nutrients for fertilizer nutrients), and soil conditioning of agricultural land. The land application of biosolids is an environmentally sound method for removal of and reuse of the residues from wastewater treatment.

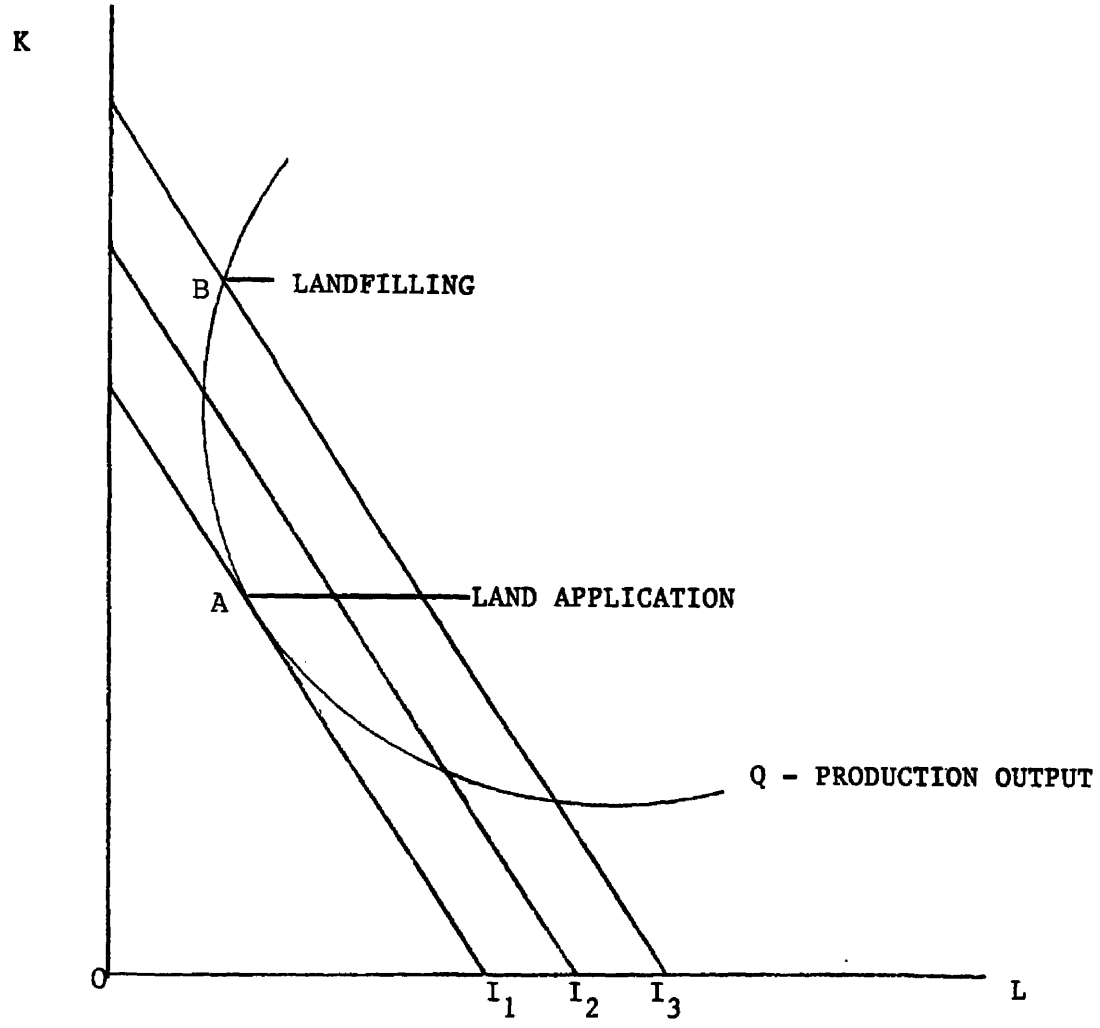
In summary, the benefits include the desired output of this study, (ie., disposal of wastewater treatment plant residues) recycling of a waste product, conservation of landfill space, and the use of an environmentally sound waste management method. In addition to the above listed benefits, this method also has some externalities which must be considered. Recycling the biosolids provides the farmer with needed nutrients and soil conditioners for the crop thus, the need for chemical fertilizers is reduced which reduces fertilizer costs. Land application of biosolids, by farmers who otherwise would not pay for commercial fertilizers to enrich their crops, increases crop yields which may in turn reduce costs to the consumer.

An evaluation of the costs and benefits of agricultural land application is described using Graph 2. The X-axis represents the cost of labor (L) and the Y-axis the cost of capital (K). Q is an isoquant of all possible combinations of

capital and labor to produce a level of production output. In this case, the production output is the disposal of solids from the wastewater treatment plant. I_1, I_2, and I_3, represent isocost lines, or alternate budgets for biosolids disposal. Increasing costs are shown by those budget lines moving up and to the right on the graph, ie. I_3 represents the largest budget. Any intersection point of the production isoquant line and a budget line gives a possible combination of capital and labor to produce the desired production output, in this case disposal.

The data from the survey would indicate that point A is representative of the land application disposal method, and point B would represent the alternate disposal options. This graph shows that the least expensive means of wastewater residue disposal is land application.

Although, a case has been made for the selection of land application using the cost benefit analysis method, the results of the survey show that although these issues are considered, the ultimate decision is made on the basis of cost effectiveness.



LEAST - COST PRODUCTION (BIOSOLIDS DISPOSAL)

K = Capital
L = Labor
I_1, I_2, I_3 = Possible production isoquants

GRAPH 2

CHAPTER 5

SURVEY RESULTS

THE SAMPLE

Michigan municipal wastewater treatment facilities that responded to the survey ranged in size from the second largest plant in Michigan treating 66 million gallons of water daily to a small plant which treats 0.8 million gallons per day. The quantities of solids disposed of by these facilities (see Table 2) ranges from 10,640 tons to 150 tons of dry solids. Eleven plants sent formal responses to the survey. Informal interviews were held with 28 other individuals who had interests in the land application program, to discussing the contents of the survey and requesting their comments. They included directors of land application programs, wastewater treatment plant superintendents, program regulators from the Michigan Department of Natural Resources, soil scientists, agronomists, and representatives from firms which contract land application programs for municipalities. The statistics referred to throughout this discussion come solely from those respondents who completed the survey. (See Tables 2 through 6.)

SURVEY RESPONDENTS

Surveys were completed by the following:

Gary Burk, Owosso, MI

Ken Langmesser, Port Huron, MI

Ken Miller, Bay County, MI

Daryle Smith, Grand Rapids, MI

Jim Spangler, Lansing, MI

Paul Vermaaten, Jackson, MI

John Vasold, Saginaw, MI

Chris Webster, Genesee County, MI

Steve Young, Midland, MI

Village of Lowell

Village of Rockwood

TABLE 2

Two of the facilities submitting the survey had changed from incineration to land application, although one continues to incinerate a small portion of its residues during the winter months and another landfills a portion of its solids when agricultural farm land is not available. Two Publicly Owned Treatment Works have no prior history of alternate disposal methods, and one facility continues to landfill while it is investigating the costs of a change. Some plants changed their method of solids disposal as long ago as 1982, while others are only this year, 1994, making the move to land application. (See Table 3.)

REASONS FOR CHANGING DISPOSAL METHOD

When responding to the question asking for the primary reason for changing from an alternate method to land application, six of eight respondents cited cost as the factor. The other two responses were from the facility which was still incinerating a portion of its solids and the facility which has not changed from landfilling. The latter respondent indicated that estimated costs of land application are equal to his landfilling costs, in which case he would recommend a change based only on the beneficial recycling issue. Other reasons enumerated as secondary to the cost, but significant to a change, included recycling benefits, lack of available landfill space, and lower cost of operation, maintenance and utilities.

POTW ALTERNATIVE SOLIDS DISPOSAL METHODS

YEAR AND REASON FOR CHANGE

PLANT	ALTERNATE DISPOSAL METHOD	YEAR CHANGED	REASON FOR CHANGE
GRAND RAPIDS	LANDFILLING	1994	COST
LANSING	LANDFILLING	1994	LOWER CAPITAL COST RECYCLING
SAGINAW	LANDFILLING	1989	COST LANDFILL AVAILABILITY
GENESEE COUNTY	LANDFILLING	1986	COST
PORT HURON*	INCINERATION	1982	COST
JACKSON**	LANDFILLING	1994	REDUCE OPERATIONAL COSTS
BAY COUNTY	NO OTHER METHOD	NA	NA
MIDLAND	LANDFILLING	1986	REDUCE OPERATIONAL COSTS
OWOSSO***	LANDFILLING	NA	RECYCLING, COSTS EQUAL
LOWELL	NO OTHER METHOD	NA	NA
ROCKWOOD	INCINERATION	1985	NO INFO PROVIDED

* PORT HURON INCINERATES DURING THE WINTER MONTHS DUE TO LACK OF STORAGE SPACE

** JACKSON LANDFILLS DURING WINTER MONTHS DUE TO LACK OF STORAGE SPACE

*** OWOSSO IS CURRENTLY INVESTIGATING LAND APPLICATION POSSIBILITIES

TABLE 3

COST AS A FACTOR

Nine POTW's ranked cost on a scale of 1-5 (5 being most important, 1 being least) as a factor for their change to land application. (See Table 4.) Of those nine, six ranked cost as the most significant factor giving it 5, one facility rated it 4 and two rated it 3. From the answers given to the last two questions, the conclusion is that cost is the most significant factor in choosing a solids disposal method by most municipal wastewater treatment plants.

COST COMPARISON

Reviewing the total dollar costs of land application programs for the responding POTW's, it was revealed that costs ranged from over $800,000 for the disposal of 10,000 tons of dry solids to as little as $14,250 for the disposal of 150 tons. The cost per ton of dry solids ranged from $48.47 to $117.00. One facility estimated its cost at $144.44 per ton but did not have actual data. (See Table 5.) Because this figure is an estimated cost, it is not included in the land application cost averages for dry tons or liquid gallons. The table shows the size of treatment facility in millions of gallons of water treated per day (design flow), the tons of dry solids produced per year, the cost per ton of an alternate method of disposal, the cost per ton for land application and the cost per gallon of

COST AS A DECISION FACTOR

PLANT	COST RANK 1-5
GRAND RAPIDS	5
LANSING	3
SAGINAW	5
GENESEE COUNTY	5
PORT HURON	4
JACKSON	5
BAY COUNTY	5
MIDLAND	5
OWOSSO	3
LOWELL	NO INFO
ROCKWOOD	NO INFO

RANKING 1 = NO SIGNIFICANCE

5 = VERY SIGNIFICANT

NO INFO = PLANT DID NOT PROVIDE ANY RANKING

TABLE 4

SUMMARY OF POTW'S SOLIDS REMOVAL COSTS

PLANT	SIZE MGD*	TONS SOLIDS	LAND APP COST $/DRY TON	COST $/GAL	ALT METHOD COST $/TON
GRAND RAPIDS	66.0	10640	58.17	0.0221	NA
LANSING	35.0	10000	82.35	0.0433	84.46
SAGINAW	32.0	5434	48.47	0.0238	68.86
GENESEE COUN	25.8	9508	54.90	0.0174	165.00
PORT HURON	20.0	2171	95.00	0.0302	163.00
JACKSON	19.0	2318	90.00	0.0184	135.00
BAY COUNTY	10.3	1281	96.02	0.0175	NA
MIDLAND	10.0	883	56.64	0.0150	156.00
OWOSSO**	4.0	900	144.00	0.0371	144.00
LOWELL	1.4	187	117.00	0.0223	NA
ROCKWOOD	0.8	150	95.00	0.0433	NA
AVERAGE			79.36	0.0253	130.90

*Plant sizes are given as design flows in millions of gallons per day
**Costs for land application at Owosso are estimated
These estimated costs are not used in calculating averages for land app

TABLE 5

liquid biosolids applied. Table 5 shows that the average cost of an alternate disposal is $130.90 per ton while the average cost of land application is $79.36 per ton and about 2.5 cents a gallon.

LAND APPLICATION PROGRAM PROBLEMS

When discussing difficulties and problems of an agricultural land application program, only two facilities indicated that procuring agricultural land was any problem at all. One of those pointed out that it takes a little more effort to recruit the land because of new "no-till" farming practices, and the discontinuance of the set aside program by the Federal government. Only one facility did not currently have enough farm land signed up for the program to completely utilize its biosolids production. This facility is an intermediate-sized plant located in southeast Michigan which requires approximately 700 acres of land for its land application program.

Weather, the seasonal nature of land application in Michigan, and farming schedules were the most often cited problems dealt with by Wastewater Treatment Plants. The second serious concern voiced by POTW's was dealing with the MDNR and the new rules it had implemented within the past two years. This issue was not only voiced by six of the nine respondents answering this question, but was voiced almost unanimously by all other managers interviewed. Each one has had some

difficulty in meeting the new requirements, although small plants with only a few tons of solids to recycle were experiencing negligible affects.

Citizen complaints and storage facility requirements ranked next on the list of concerns for biosolids recyclers. Other problems encountered included equipment breakdown during application season, public relations, and pathogen reduction requirements.

BENEFITS OF LAND APPLICATION

When it came to touting the benefits of land application two things that were mentioned by all but one facility were its lower cost over alternate methods of disposal (listed as number 1) and recycling of nutrients. (See Table 6.) The facility that did not list cost as a benefit has never used another method of biosolids disposal. Many listed reduced operations and maintenance costs as another benefit. The conservation of landfill space was also recognized as a benefit.

BENEFITS OF ALTERNATE DISPOSAL METHODS

The biggest disadvantage of land application proved to be the most significant benefit of the other methods. That benefit was year round availability with no seasonal restrictions. Other advantages included the following: reduced liability, no need for storage facilities, solids volume

BENEFITS OF AGRICULTURAL LAND APPLICATION OF BIOSOLIDS

CITY	COMMENTS
Grand Rapids	Public relations of recycling movement Cost savings
Lansing	Better utilization of product Reduced utility requirements Less equipment intensive, lower capital cost Comparable disposal costs
Saginaw	Lower Cost Recycles a byproduct Free fertilizer to farmers Preserves landfill space Reduces need for chemical fertilizers
Genesee County	Economically efficient over other methods Environmentally friendly Less equipment required, less labor Preserves landfill space Regs. on other methods becoming more stringent
Port Huron	Preserves landfill space An efficient and successful program
Jackson	Less solids handling required Reduced labor costs Recycling nutrients
Bay County	Reduced Costs Reuse of biosolids Soil Conditioning
Midland	Reduced disposal costs Reduced return loading on plant Reduced energy consumption Reduced chemical costs General improvement in plant operation
Owosso	Recycling nutrients & conditioning soils Less solids handling, no dewatering Cost effective
Lowell	Recycles biosolids & nutrients Preserves landfill space Conserves energy
Rockwood	Lower Cost Beneficial reuse of biosolids Preserves landfill space

TABLE 6

reduction by incineration, less monitoring required by MDNR, fewer public relations problems, possibility of methane recovery from landfills, and no recruiting of farmers. Of these comments, only the issue of reduced liability was mentioned by more than one individual.

COMMENTS ABOUT LAND APPLICATION

Every facility using agricultural land application of biosolids as a method for reuse/disposal of its solids had positive comments to make. Some comments described the success of programs which had been in place for as long as 12 years, while others explained the benefits which were expected from programs just beginning. Nearly all respondents were pleased to be engaged in a recycling program rather than a disposal program. A summary comment might be that land application was efficient and cost effective.

One facility felt that it had been dealt such a hard blow by the new MDNR rules that it is currently considering leaving the program, even while acknowledging that land application is most cost effective. In contrast, a relative newcomer to the land application alternative expressed that this new program had provided significant improvements in the overall plant operations, while reducing solids disposal costs.

CHAPTER 6

CONCLUSIONS AND IMPLICATIONS OF FINDINGS

Land application of biosolids is chosen by municipalities because it is the least expensive means of disposal. Several beneficial externalities of land application exist and must be considered significant. Biosolids application to farm land provides the farmer with crop nutrients that can reduce the amount of chemical fertilizers needed. By applying biosolids to farm land, municipalities are not competing for scarce landfill space. Freeing landfill space for other uses helps keep the cost to the public lower. However, all these benefits are not the compelling reason for the use of land application; municipal wastewater treatment plant budget dollars and cents are the reason.

A noteworthy negative benefit to the use of land application is public perception. The fear of pollution and distrust of government lead the public to view the program as dangerous to human health. The safety and benefits of the program are difficult to impart to a skeptical public. Media coverage can enhance the fear of others when unfounded accusations are made by a few who for various reasons, do not like the land application program[12]. Results of investigations and verification of claims are rarely published. It is

difficult to eliminate suspicion once it is planted by sensationalized journalism. The biggest problem is an uninformed media reporting charges which have not been fully investigated.

Landfilling as a disposal method does not share the public relations problem. Municipalities would opt for this disposal method, if the cost were not prohibitive. Scarcity of landfill space due to limited permits by the Michigan Department of Natural Resources and the exorbitant cost of construction has driven the cost of landfill disposal up well beyond land application costs[13].

With these facts in mind, municipalities choose agricultural land application for biosolids reuse and disposal. This implies that some of the money saved on the direct disposal costs will be used to educate and inform the public about the program. Acceptance of land application of biosolids by the public hinges on each POTW helping to accomplish this public relations effort. To provide data to the public on the safety of land application, biosolids analyses results must be made available to them. Soil sampling and analysis are critical to assure the public that no pollution is taking place. Better trained staff managing the program is mandatory and this staff must be capable of dealing with public complaints, as well as of informing the interested farmer of the direct benefits of the of land application.

To assure that the biosolids are free from dangerous pollutants, each POTW must expand its industrial pretreatment program. This requires surveying and monitoring of all nondomestic sewer users in a municipality's jurisdiction. The intent of this program is to limit introduction of industrial pollutants to the collection system and, thereby, limit their introduction into the wastewater treatment plant and subsequently into its biosolids. This program is currently mandated by the Clean Water Act, and its effectiveness has been demonstrated based on information collected by the National Sewage Sludge Survey. Facilities must continue to increase the budget for the industrial pretreatment program to provide the needed protection for biosolids disposal programs if agricultural land application is chosen as a disposal method.

Based on results reported, land application of municipal wastewater biosolids is the most cost effective method of disposal and provides many external benefits. However, hidden costs exist, which include the necessity of public education and a public relations program, additional testing and record keeping, and a more highly trained staff. Additional costs may also be incurred by the necessity of other programs (eg., industrial pretreatment) designed to protect the land application program itself. Consequently, although it is cheaper and more ecologically beneficial to use land application, most municipal wastewater treatment plants would use landfilling if they could justify the additional cost.

APPENDIX 1

MICHIGAN
WASTEWATER TREATMENT FACILITIES WHICH RECEIVED SURVEY FORMS

	Facility	Superintendent/Program Manager
	Class A	
1.	Ann Arbor	Mike Adrounie
2.	Adrian	Royce Deline
3.	West Bay County*	Ken Miller
4.	Benton Harbor/St. Joseph	Allyn Ernst
5.	East Lansing	John Halas
6.	Frankenmuth	Dan Geyer
7.	Genesee County*	Chris Webster
8.	Grand Haven	John Stuparits
9.	Grand Rapids*	Daryle Smith
10.	Jackson*	Paul Vermaaten
11.	Lansing*	Jim Spangler
12.	Midland*	Steve Young
13.	Monroe	Dan Stefanski
14.	Mt. Clemens	Paul Hendricks
15.	Niles	Larry DeLong
16.	Pontiac	Leonard Briscoe
17.	Port Huron*	Ken Langmesser
18.	Saginaw*	John Vasold
19.	Wayne County-Wyandotte	Robert DeLong
20.	Wyoming	Dan Wolz
21.	Ypsilanti	Larry Thomas
22.	Warren	Gerald Herriman

APPENDIX 1 (continued)

MICHIGAN

WASTEWATER TREATMENT FACILITIES WHICH RECEIVED SURVEYS

	Facility	Superintendent
	Class B	
23.	Bridgeport	Joe Goergen
24.	Buena Vista	William Menery
25.	Cadillac	Larry Campbell
26.	Holland	David Verhoef
27.	Lowell*	WW Operations Services
28.	Owosso*	Gary Burk
29.	Rockwood*	WW Operations Services

* These facilities returned completed surveys.

APPENDIX 2

LAND APPLICATION AND BIOSOLIDS DISPOSAL SURVEY

1. Questions concerning landfilling/incineration of biosolids.

   a. Last year of landfilling or incineration. (please indicate which)

   _____

   b. Cost of disposal (last year of landfilling or incineration.)

   _____

   c. Estimated current cost to landfill or incinerate.

   _____

   d. Dry tons disposed of (last year of alternate disposal.)

   _____

   e. Cost per ton.

   _____

2. Primary reason for switch from landfilling/incineration to land application.

   _____

   _____

3. How big a factor was cost in your decision? Please rank cost on a 1-5 scale 5 being the most important reason for your decision & 1 being of little or no importance in your decision.

   _____

4. Questions concerning land application of biosolids.

   a. Total cost of land application per year.

   _____

   b. Million gallons applied.

   _____

   c. % solids.

   _____

   d. Dry solids applied.

   _____

   e. Cost per ton dry, cost per gallon.

   _____

5. Number of acres required for land application of all biosolids.

_____

6. Do you have more or fewer acres than you need for your program?

_____

7. Do you have difficulty recruiting land?

_____

8. Primary problems with land application (please rank them.)

1. _____
2. _____
3. _____
4. _____
5. _____

9. Benefits of landfilling/incineration over land application.
(please rank them)

1. _____
2. _____
3. _____
4. _____
5. _____

10. Benefits of land application over landfilling/incineration.
(please rank them)

1. _____
2. _____
3. _____
4. _____
5. _____

11. Comments on land application versus landfilling/incineration of biosolids.

_____
_____
_____
_____

NOTES

1. Interviews were given by the following individuals:

Michael Adrounie, Assistant Superintendent, Ann Arbor, MI
Paul Blakeslee, Surface Water Quality Div, MDNR
Barry Burns, Surface Water Quality Div., MDNR
Gary Burk, Public Utilities Director, Owosso, MI
Graham Chapman, Superintendent, Delta Township, MI
Charles Cubbage, Mich. Department of Agriculture
Robert Deatrick, Waste Management Div., MDNR
Fred DeCamp, Enviroland Inc., (retired MDNR Land Application Unit)
Cindy Drill, N-Viro, Inc.
Allyn Ernst, Superintendent, St. Joseph-Benton Harbor, MI
Joe Goergen, Superintendent, Bridgeport, MI
Dan Hall, Superintendent, DeWitt, MI
Lee Jacobs, Dept. of Crop & Soil Science, MSU
Ken Langmesser, Land Application Program Manager, Port Huron, MI
Jeff List, Waste Management Div., MDNR
William Menerey, Superintendent, Buena Vista, MI
Bruce Merchant, Assistant Superintendent, Kalamazoo, MI
Ken Miller, Superintendent, Bay County, MI
Daryle Smith, Superintendent, Grand Rapids, MI
Jim Spangler, Superintendent, Lansing, MI
Joe Staph, Utilities Director, Wyoming, MI
Daryl Tammen, President, Michigan Organic Resources
John Vasold, Superintendent, Saginaw, MI
David Verhoef, Superintendent, Holland, MI
Paul Vermaaten, Land Application Program Manager, Jackson, MI
Chris Webster, Land Application Program Mgr., Genesee County, MI
Dan Wolz, Superintendent, Wyoming, MI
Steve Young, Superintendent, Midland, MI

2. Michigan Department of Natural Resources, *Michigan Munipipal Wastewater Facility and Certification Listing,* compiled by the Surface Water Quality Division, Sept. 21, 1993. The list contains the names and addresses of all Michigan municipal wastewater treatment plants, superintendent's name, plant class, size, other plant specifics.

3. Ocean dumping was banned in October 1993 with the issuance of Federal Regulation 503 which regulates sludge (biosolids) use and disposal.

4. Paul Blakeslee is a District Supervisor with the Surface Water Quality Division of the Michigan Department of Natural Resources (MDNR) and Fred DeCamp (retired from the MDNR former Land Application Unit) is currently is contracting his services to Enviroland, Inc., a land application contractor. These men discussed the changes they have witnessed in solids disposal alternatives used by POTW's.

5. Jim D. Anderson, P.E., retired, Superintendent, City of Saginaw Wastewater Treatment Plant, provided information from the preparation of FY 1977 Wastewater Treatment Division budget.

   Robert Thornton is the Facility Manager of Citizens Disposal Corp., Grand Blanc, Michigan. He discussed nearly annual increases in tipping fees as landfill construction costs increase.

6. Robert Deatrick, Waste Characterization Unit, Waste Management Division, MDNR.

7. Robert Thornton, see note 5.

8. These incidents were documented in the following:

   Schmidt, Wayne, DNR Targets Six Polluted Sites In Michigan," *Flint Journal,* from the Lansing News Bureau, April 27, 1986, p. A6.

   The State of Alaska, Plaintiff, vs. Exxon Corporation, Defendant, Case No. 3AN8906852CIV, In the Supreme Court for the State of Alaska, Third Judicial District, ENVIRONMENTAL LAW AND POLICY: NATURE, LAW, AND SOCIETY, Plater, Abrams, Goldfarb, West Publishing, St. Paul, MN, 1992, pp.163-170.

   Wilkins, Lee, SHARED VULNERABILITY: THE MEDIA AND THE AMERICAN PERSPECTIVE, Greenwood, New York, New York, 1987.

9. Increased crop yields may be experienced by those farmers who use biosolids nutrients on their crops when they would otherwise not apply any fertilizer. Biosolids are provided at no cost to the farmer. The application and soil testing costs are paid by the municipality.

10. "No-till" is the farming practice where incorporation of residues (eg., by plowing of crop fields) is avoided. Organic material from previous crops is allowed to remain on the soil surface to help minimize loss of top soil.

11. Joan Peck, Chief, Waste Characterization Unit, Waste Management Division of the MDNR in 1992 instituted policies for an expedited approval process for agricultural land to be used for land application. This expedited policy requires notification of all property owners within 800 feet of the proposed application site and prohibits application between December 21 and March 21 of each year. Winter application is not allowed under the new policy.

12. See Hagg 1992.

13. Manigeh Garakani, PhD., City Management Corporation, Detroit, MI, commented on the difficulties of procuring the construction permits for the Brent Run Landfill, Montrose, MI.

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