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Use of Landfarming to Remediate Soil Contaminated by Pesticides

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WMRC
One E. Hazelwood Drive
Champaign, IL 61820
217-333-8940 (phone)

www.wmrc.uiuc.edu

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Use of Landfarming to Remediate Soil Contaminated by Pesticides

by

Andrews Environmental Engineering, Inc.
Division of Remediation Services
3535 Mayflower Boulevard
Springfield, IL 62707

Prepared for
Hazardous Waste Research and Information Center
One East Hazelwood Drive
Champaign, Illinois 61820

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American Cyanamid
Agricultural Division
1 Cyanamid Plaza
Wayne, New Jersey 08540

D.L. Paulson, Jr.
Ciba Geigy Corporation
Agricultural Division
Post Office Box 18300
Greensboro, North Carolina 27419

R.M. Van Patten
Vigoro Industries, Inc.
2007 West Highway 50, Post Office Box 4139
Fairview Heights, Illinois 62208-2928

Edgar L. Ready, III
ICI Agricultural Products
Concord Pike & Murphy Road
Wilmington, Delaware 19897

Neil Wenning
DuPont Agricultural Products
Walkers Mill, Barley Mill Plaza
Post Office Box 80038
Wilmington, Delaware 19880-0038

Len Dobbins
FMC Corporation
Agricultural Chemical Group
3535 East 96th Street, Suite 114
Indianapolis, Indiana 46240

Susan Croce Kelley
Sandoz Crop Protection
Corporate Headquarters
1300 East Touhy Avenue
Des Plaines, Illinois 60018

Paul Foster, Senior Vice President
Terra International, Inc.
600 Fourth Street
Sioux City, Iowa 51101

Jack Dutra
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4551 West 107th, Suite 245
Overland Park, Kansas 66207

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Post Office Box 13528
Triangle Park, North Carolina 27709

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Technical Writer and Advisor
Dwight J. Roberts
Environmental Engineer
Andrews Environmental Engineering, Inc.
3535 Mayflower Boulevard
Springfield, Illinois 62707
(217) 787-2334

Editor
Kim A. Roberts
Communications Specialist
Roberts Communications
401 North Rose Drive
Auburn, Illinois 62615
(217) 438-6365

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ABSTRACT

Landfarming is a cost effective solution to remediating soil and groundwater that have been impacted by pesticides. This remediation technique is a safe, sound and ideal solution for agribusinesses that want to take care of the environment without going bankrupt.

With the promulgation of legislation allowing landfarming of pesticide contaminated or impacted soils, Illinois is progressing to explore alternative remediation technologies. Andrews Environmental Engineering, Inc. (AEEI) has permitted and managed the majority of the pesticide landfarming projects since authority was granted to the Illinois Department of Agriculture (IDOA) in July, 1990 to review and authorize these projects. This publication discusses, reviews and summarizes case studies on eighteen pesticide landfarming projects undertaken by AEEI. In-depth cost summaries are also provided for six of the pesticide landfarming projects.

The cost analysis proves that landfarming is a highly cost effective remediation technique. The average cost to complete a landfarming project, from site investigation to field closure was $22 per ton. While cost effectiveness is a major issue for pesticide landfarming projects, the continued success of landfarming is dependent upon maintaining landfarming as a safe and efficient means for solving the challenges of environmental clean-ups. The landfarming process must be closely managed and monitored. Several project management issues need to be addressed with every landfarming project. Prospective participants in the process must be educated, sites must be adequately characterized, spreading rates must be carefully calculated and application must be consistent.

Landfarming has succeeded as a safe means of remediation for pesticide-impacted sites. It has proven to be cost effective, while maintaining protection to the environment. Therefore, the authority for land application of water and soil pest-impact should be continued. This should be administered on a permanent basis so that standardized operational controls and sampling and analysis plans can be established. This will define clear requirements and eliminate apprehension in participation of pesticide landfarming projects.

Also, authority for landfarming of gravel/rock, fertilizer impacted soil and water, and soil and water from transportation-related agrichemical accidents should be granted. These landfarming projects should be administered under one program. All of these issues will help maintain consistency and insure the success of landfarming as a safe and cost effective means of site remediation in the State of Illinois.

EXECUTIVE SUMMARY

The purpose of this publication is to discuss and summarize landfarming projects undertaken by Andrews Environmental Engineering, Inc. (AEEI). The use of landfarming to remediate soil contaminated by pesticides was made possible through legislation which granted the Illinois Department of Agriculture (IDOA) the authority to review and authorize these projects.

This discussion of the landfarming process and issues associated with it helps to identify key areas which will help ensure the safety and success of landfarming's future. As with any successful task, education is an important function. All those involved must be thoroughly educated on landfarming in order to feel comfortable and confident that the process will work.

When using landfarming as a remediation technique, certainly a primary objective is to adequately protect the environment during the process. This is achieved by close management and accurate data representation while still keeping the process cost effective. Adequate characterization of the soil to be landfarmed is achieved by sampling. Once the sample results are available and pesticide concentrations are known, then application rates can be determined and field selection can begin. Knowledge of the pesticides and their intended use is important when determining the rates at which soil will be spread.

When starting field application, care must be taken to correctly calibrate the spreading equipment. Some spreading equipment is better suited for certain soil types. For example a lime spreader may work well when spreading sandy soil but may not be effective when spreading clayey soils. The spreading techniques and soil types determine the consistency of soil application. Since soil is not a consistent material, uniform soil application is not always possible. Some crop yield loss is expected, whether it is due to soil compaction from equipment or due to herbicide concentrations from uneven soil application. These concerns can be addressed through contractual agreements with the land owner and providing compensation for crop yield loss.

When soil spreading is completed, the landfarming process is not done. The field should be monitored throughout the growing season and soil samples should be taken. The field soil samples are necessary to verify that the pesticides have adequately degraded and that pesticide concentrations will not produce carryover effects on next season's crops.

As long as care is taken in managing the landfarming of pesticide contaminated soils, the remediation technique should be allowed to continue. This technology is cost-effective and is valuable in preserving landfill space. Given the success of this program, other considerations should be made concerning the use of landfarming.

Landfarming of pesticide contaminated water would be useful since application of the water would be more consistent and easier to control than application of the soil. Authority to landfarm pesticide contaminated gravel and rock is also recommended since most agrichemical facilities have gravel around the facility which spillage may have occurred in the past. The gravel and rock can be spread on farm field roads out in a field. Landfarming of soil and water

impacted by fertilizers or nutrients as well as soil and water from transportation-related accidents is also recommended. Fertilizers are also an agrichemical and are no more of a potential hazard than pesticides.

To maintain consistency, it is also recommended that all of these considerations be managed under one program to be reviewed and permitted by the Illinois Department of Agriculture. The safety and success of landfarming will be maintained if all landfarming projects are permitted under one program by one agency.

1.0 BACKGROUND

1.1 Prelude to Landfarming

The passage of the Responsible Property Transfer Act (RPTA 85-1228) and banking industry liability concerns caused a marked increase in the number of environmental property audits conducted in Illinois after 1988. At this time the agrichemical industry was also undergoing major consolidation and ownership changes due to the Illinois Department of Agriculture (IDOA) Part 255 agrichemical facility regulations. The combined effect of RPTA and Part 255 regulations caused many agrichemical facilities to be placed on the market and have environmental property audits conducted on the sites.

The results of environmental property audits frequently identified pesticides in soils at levels exceeding those thought to be acceptable by Illinois Environmental Protection Agency (IEPA). One of the consultants performing environmental property audits at such facilities was Andrews Environmental Engineering, Inc. (AEEI) of Springfield, Illinois. It became apparent to AEEI, in consultation with clients, that they did not favor excavation and landfilling of the pesticide-contaminated soils. The clients were concerned about the cost and long term liability associated with landfilling.

As a remedial action option, AEEI was aware that the IEPA Office of Emergency Response and some IEPA regional offices had authorized landfarming of pesticide contaminated soil from transportation-related accidents. However, the use of this technology was not widespread and its proper regulatory context was, at best, ill-defined.

1.2 Implementation of Landfarming Program

Representatives of AEEI sought support from the Illinois Fertilizer and Chemical Association (IFCA) and the Hazardous Waste Research and Information Center (HWRIC) for a research project to evaluate landfarming technology. Dr. Allan Felsot of the Illinois Natural History Survey and James Frank, Vice President, Division of Remediation, AEEI, obtained a grant from HWRIC with matching funds from IFCA to conduct such a study.

IFCA approached IEPA and IDOA to seek their support for a two year trial program to allow soils containing pesticides to be landfarmed. With IEPA support, the trial program was approved as Public Act 86-1172.

The adoption of the law and its subsequent amendment to allow water containing pesticides to be landfarmed allowed AEEI to conduct 18 such projects. Seventeen of those projects dealt with soil and one dealt with fire control and cleanup water. IDOA approved four other projects in addition to these 18.

1.3 Roles and Responsibilities

Dr. Felsot's role in the project was to conduct fate and transport studies of pesticide movement in surface and groundwater as well as to evaluate plant phytotoxicity and degradation of pesticides. AEEI's role was to conduct multiple projects and evaluate the operational control procedures used in the application fields. AEEI initially proposed to IDOA a set of operational control procedures derived from other landfarming programs: i.e., Iowa's fuel program; Illinois sewage sludge and livestock waste programs. These original controls were modified by IDOA and used in their approvals of the projects. AEEI will evaluate the suitability of the controls and suggest appropriate modifications and/or additions in this report.

2.0 INTRODUCTION TO THE LANDFARMING PROCESS

2.1 Introduction

Waste disposal and remediation can be a very costly and time-consuming process. Industries are constantly looking for cheaper and quicker methods of remediating contaminated sites. In Illinois, the common method of dealing with contaminated soil is to dispose of it in a landfill; however, landfill space is quickly dwindling and becoming more costly. Luckily, other methods of disposal exist, such as landfarming. Instead of concentrating contaminated soils in landfills and increasing the hazard associated with them, landfarming can remediate or eliminate the hazard as well as preserve landfill space.

Landfarming is the process by which soil containing pesticides is applied to farm fields so that natural degradation of pesticides in their intended environment can occur; thus, resulting in remediation of the soil so it is no longer harmful. The application of soil must be properly controlled and managed to ensure adequate remediation without affecting the farm field system to which it is applied.

The experiences of using landfarming to remediate soil containing pesticides is the focus of this report. This is a unique situation since, unlike hazardous waste, pesticides are commonly applied to farm fields; landfarming the soil can be agronomically beneficial to crops grown in the fields.

2.2 Pesticide Concentrations

Because agrichemical facilities store, handle, mix and apply pesticides, they are a common source of pesticide contaminated soil. The task of identifying which pesticides and what areas have been impacted can be difficult since these agrichemical facilities handle several products. The properties of all chemicals vary; for instance, one chemical may be more soluble in water than another. Therefore, one chemical can impact a much larger area than another chemical since it can move more easily in certain media or soil types.

Based on previous experiences and cases, AEEI developed a list of chemicals commonly found in the soil at various agrichemical sites. Once a site has been determined to be contaminated, it must be assessed to determine the kinds and concentrations of chemicals present. An assessment of the area impacted by the pesticides must also be completed to make an estimate of the volume of soil contaminated by the pesticide waste. Once the site assessment is completed, soil samples are analyzed to identify and quantify chemical concentrations. The next task is to determine the proper spreading rates and the optimum method of application to be used in the field.

The soil must be applied at label rates as recommended by the chemical manufacturer and according to state and federal regulations. The chemical concentrations within the soil determines the rate (tons/acre) at which the soil is applied to the field. The volume of soil previously estimated from the site assessment will then determine how much acreage is needed to landfarm the pesticide containing soil.

2.3 Soil Spreading

Contaminated soil is excavated from the site and transported to the fields where it will be spread by one or more methods. The methods for soil spreading depend on the type of soil being remediated. For example, some soil types require the use of specialized or modified equipment in order to provide proper soil spreading. For adequate remediation and farming purposes, it is essential that the soil be spread properly. Proper soil spreading requires that the contaminated soil be spread evenly and uniformly, since it is undesirable for the soil to be left in large piles or strips throughout the field. This can be difficult since the soil may not be consistent or homogeneous.

The designated farm field is then sampled for the chemicals which are being landfarmed prior to and one year after soil spreading has taken place. This sampling documents chemical concentrations to confirm any background concentrations that may have been present prior to spreading the soil. It also certifies that any pesticide in the soil has properly degraded. A report is then prepared that discusses the landfarming process, volume of soil applied, crops grown and pesticide concentrations before and after soil application.

3.0 CASE STUDIES OF 18 ILLINOIS LAND FARMING SITES

Narrative Summaries of 18 Sites

Each agrichemical facility is unique. The major differences are age, historic use and the various pesticides and fertilizers that are received, stored, mixed and loaded at each site. A narrative summary of 18 landfarming projects undertaken by AEEI follows.

A discussion and summary of the costs for the first six sites is included in chapter 4.0. This summary provides the most comprehensive cost information available at this time.

Case Study #1

An investigation by the Illinois Environmental Protection Agency prompted the site owner to seek land spreading as a method of site remediation. AEEI then collected soil samples from a load pad area, a bermed area that held the surface runoff on site and a traffic area. Analytical results revealed that the highest concentrations of pesticide was Alachlor at 29 ppm at the zero to six inch depth and 110 ppm at the six to twelve inch depth.

As a result of the sample findings, AEEI estimated that 4,368 tons of contaminated soil and 155 tons of contaminated gravel would need to be excavated. AEEI calculated that, based on the highest concentration of Alachlor, 98 acres of cornfield would be used to land spread the contaminated soil at a rate of 25-60 tons per acre. A Land Application of Herbicide Contaminated Soils permit application was then submitted to IDOA, which approved the permit application.

The soil was excavated and hauled to the receiving field, some of which was government set-aside acreage. A double-axle manure spreader was then used to spread the excavated soil; the soil/gravel mixture was hauled and spread on farm field roads.

Case Study #2

The site owners requested an environmental property audit be performed by AEEI prior to construction of a new containment and load pad facility to determine the extent of any soil contamination. AEEI then collected soil samples from around a load pad, former loading area and the location of the liquid fertilizer tanks and the surface water runoff area.

Analytical results revealed that the highest concentration of pesticide was Alachlor at 210 ppm at the zero to six inch depth. Based on the sample results, AEEI estimated that 603 tons of contaminated soil and 160 tons of contaminated gravel would need to be excavated. AEEI then calculated that, based on the highest concentration of Alachlor, 10.5 acres of cornfield would be used to land spread the contaminated soil at a rate of 45 to 60 tons per acre.

AEEI conducted the environmental property audit, supervised the sampling event and determined the amount of soil to be excavated and the spreading rate. AEEI then submitted a Land Application of Herbicide Contaminated Soil permit application to IDOA, which approved the permit application.

The soil was excavated and hauled to the field where it was land applied with a truck-mounted soil spreader.

Case Study #3

The Illinois Environmental Protection Agency requested that the owner perform a study and appropriate remediation of the site. The owner selected land spreading of the contaminated soil as a means of achieving site remediation. AEEI collected soil samples in the equipment packing area, well water loading area, around the load pad, near the chemical warehouse and from the liquid nitrogen storage tank area.

Analytical results revealed that the highest concentrations of pesticide was Alachlor at 1.3 ppm at the zero to six inch depth. As a result of the sample findings, AEEI estimated that 2,865 tons of contaminated soil would need to be excavated. AEEI also calculated that, based on the highest concentration of Alachlor, 20.5 acres of cornfield would be used to land spread the contaminated soil at a rate of 25-60 tons per acre.

AEEI submitted a Land Application of Herbicide Contaminated Soils application to IDOA, which approved the permit application. The soil was then excavated and hauled to the field. Since the excavated soil had a high sand content, two truck-mounted lime spreaders were used to effectively spread the soil.

Case Study #4

A railroad commissioned an environmental property audit of their property that is leased to an agrichemical company. The railroad found soil contamination and decided that a cleanup needed to be performed. AEEI took samples from around two load pads, the traffic flow area and the application equipment parking area.

Analytical results revealed that the highest concentrations of pesticides were Atrazine at 2.6 ppm at the zero to six inch depth and Trifluralin at 3.1 ppm at the zero to six inch depth. After reviewing the sample findings, AEEI estimated that a total of 9,718 tons of contaminated soil and gravel needs to be excavated. The project was divided into two phases to be conducted over two years. To date, 2,895 tons of contaminated soil and 625 tons of contaminated gravel have been excavated.

AEEI calculated that, based on the highest concentration of Atrazine, 40 acres of corn field would be used to land spread the contaminated soil at a rate of 60 tons per acre; based on the highest concentration of Trifluralin, 123 acres of soybean land would be used at a spreading rate of 60 tons per acre. To date, 53 acres of cornfield have been spread with the Atrazine-contaminated soil.

AEEI conducted the environmental property audit, supervised the sampling event, and determined the amount of soil to be excavated and the spreading rate. AEEI then submitted a Land Application of Herbicide Contaminated Soil permit application to IDOA, which approved the permit application.

The soil, which was mostly sand, was excavated and hauled to the field where it was land applied with a mounted high-flotation soil spreader. The soil/gravel mixture was then hauled and spread on farm field roads.

Case Study #5

The owner wanted to complete the soil remediation necessary prior to constructing a new facility on the property. He selected land farming as the remediation option. AEEI obtained soil samples from the proposed new facility area as well as from the existing operations areas.

Analytical results revealed that the highest concentrations of pesticides were Metolachlor at 2.1 ppm at the zero to six inch depth and Trifluralin at 1.2 ppm at the zero to six inch depth. Based on the sample results, AEEI estimated that 1,842 tons of contaminated soil and 280 tons of contaminated gravel would need to be excavated. AEEI calculated that, based on the highest concentration of Metolachlor, 11 acres of cornfield would be used to land spread the contaminated soil at a rate of 60 tons per acre; based on the highest concentration of Trifluralin, 19 acres of soybean field would be used to land spread the contaminated soil at the same rate.

AEEI then submitted a Land Application of Herbicide Contaminated Soils application to IDOA, which approved the permit application. The soil was excavated and hauled to the field where it was spread via a double-axle manure spreader. The soil/gravel mixture was then hauled and spread on farm field roads.

Case Study #6

The site owner wanted to clean up the site prior to constructing a new agrichemical facility. AEEI collected samples from soil borings made around old nitrate and phosphorus containment structures.

Analytical results revealed that the highest concentrations were Nitrate at 3100 ppm at the 8.5 to 13.5-foot depth and Alachlor at .67 ppm at the 3.5 to 8.5-foot depth. Based on the sample results, AEEI estimated that 12,960 tons of contaminated soil would need to be excavated. AEEI calculated that, based on the highest concentrations of Nitrate and Alachlor, 80 acres of corn field will be used to land spread the contaminated soil at a rate of 233 tons per acre.

AEEI then submitted a Land Application of Herbicide Contaminated Soils application to IDOA, which approved the permit application. The soil will be excavated and hauled to the field where it will be spread using a mounted spreader.

Case Study #7

An investigation by the Illinois Environmental Protection Agency determined that site clean up was necessary. This prompted the site owner to seek land spreading as a method of site remediation. AEEI collected soil samples from the load pad area, bermed area that held the surface runoff on site and traffic flow area.

Analytical results revealed that the highest concentration of pesticide was Metolachlor at 34 ppm at the zero to six inch depth. Based on the sample findings, AEEI estimated that 4,350 tons of contaminated soil and 299 tons of contaminated gravel would need to be excavated. AEEI calculated that, based on the highest concentration of Metolachlor, 177 acres of cornfield would be used to land spread the contaminated soil at a rate of 20-60 tons per acre.

AEEI then submitted a Land Application of Herbicide Contaminated Soils application to IDOA, which was approved. The contaminated soil at this site was partially excavated; however, excavation was postponed because of inclement weather.

Case Study #8

Prior to construction of a new containment and load pad facility, an environmental audit was performed by AEEI to determine the extent of any soil contamination. Soil samples were taken from around the proposed load pad area.

AEEI estimated that 605 tons of contaminated soil and 160 tons of contaminated gravel would need to be excavated. After partial excavation had been completed, AEEI obtained additional samples which indicated that more excavation was required. AEEI has estimated that an additional 3,078 tons need to be excavated. AEEI also calculated that, based on the highest concentration of Metolachlor at 1.9 ppm, 91 acres of cornfield would be used to land spread the contaminated soil at a rate of 60 tons per acre.

AEEI conducted the environmental property audit, supervised the sampling event, determined the amount of soil to be excavated and the spreading rate. AEEI then submitted an amended Land Application of Herbicide Contaminated Soil application to IDOA which was approved. The soil will be excavated and hauled to the field where it will be land applied with a mounted soil spreader.

Case Study #9

The owner wanted to complete the soil remediation necessary prior to constructing a new facility on the property. He selected land farming as the remediation option. AEEI obtained soil samples from the proposed new facility area as well as from the existing operations areas.

Analytical results revealed that the highest concentrations of pesticides were Alachlor at 0.99 ppm at the zero to six inch depth and Trifluralin at .53 ppm at the zero to six inch depth. AEEI estimated that 468 tons of contaminated soil and 65 tons of contaminated gravel would need to be excavated.

AEEI calculated that, based on the highest concentration of Alachlor, four acres of cornfield would be used to land spread the contaminated soil at a rate of 55 tons per acre. Based on the highest concentration of Trifluralin, 4.5 acres of soybean field would be used to land spread the contaminated soil at the same rate.

AEEI then submitted a Land Application of Herbicide Contaminated Soils application to IDOA, which was approved. The soil will be excavated and hauled to the field and spread using a manure spreader. The soil/gravel mixture will be hauled and spread on field roads.

Case Study #10

After a fire occurred at the facility, the Illinois Environmental Protection Agency requested that the owner perform a study and appropriate remediation of the site. The owner then selected land spreading of the contaminated soil as a means of achieving site remediation. AEEI collected soil samples in the equipment packing area, well water loading area, around the load pad, near the chemical warehouse and from the liquid nitrogen storage tank area.

Analytical results revealed that the highest concentration of pesticide was Metolachlor at 68.0 ppm at the zero to six inch depth. Based on sample findings, AEEI estimated that 980 tons of contaminated soil would need to be excavated. AEEI calculated that, based on the highest concentration of Metolachlor, nine acres of cornfield would be used to land spread the contaminated soil at a rate of 60 tons per acre; 5 acres of soybean field would be used to land spread the contaminated soil at the same rate.

AEEI then submitted a Land Application of Herbicide Contaminated Soils application to IDOA, which was approved. Since the excavated soil had a high sand content, a truck-mounted lime spreader and a manure spreader were used in order to effectively spread the soils.

Case Study #11

The owner wanted to complete the soil remediation necessary prior to constructing a new facility on the property. He selected land farming as the remediation option. AEEI then obtained soil samples from the proposed new facility area as well as from the existing operations areas.

Analytical results revealed that the highest concentrations of pesticides were Atrazine at 36.0 ppm at the zero to six inch depth and Trifluralin at 7.5 ppm at the zero to six inch depth. Upon examination of the sample results, AEEI proposed that 2,134 tons of contaminated soil and 360 tons of contaminated gravel needed to be excavated.

AEEI calculated that, based on the highest concentrations 59.5 acres of cornfield would be used to land spread the contaminated soil at a rate of 60 tons per acre and 19.0 acres of soybean land would be used at a spreading rate of 30 tons per acre.

A Land Application of Herbicide Contaminated Soils application was submitted by AEEI to IDOA, which approved the application. The soil was then excavated and hauled to the fields and spread with a manure spreader. The soil/gravel mixture was hauled to and spread on a field road.

Case Study #12

The owner wanted to complete the soil remediation necessary prior to constructing a new facility on the property along with a former rinse water lagoon area. He then selected land spreading as the remediation option. AEEI obtained soil samples from the proposed new facility and former lagoon area as well as potential runoff channels.

Analytical results revealed that the highest concentration of pesticide was Trifluralin at 49.6 ppm at the "blended stockpile." Based on the sample results, AEEI proposed that 7,944 tons of contaminated soil and 1,012 tons of contaminated gravel needed to be excavated. AEEI calculated that, based on the highest concentration of Trifluralin, 805.0 acres of soybean field would be used to land spread the contaminated soil at a rate of 10 tons per acre.

AEEI submitted a Land Application of Herbicide Contaminated Soils Permit application to IDOA, which approved the application. The soil was excavated and hauled to the field where it was spread using a mounted spreader. The soil/gravel mixture was then hauled and spread on a field road.

Case Study #13

The owner wanted to complete the soil remediation necessary prior to constructing a new facility on the property. He selected land spreading as the remediation option. AEEI collected soil samples from the proposed new facility area as well as from an existing operations areas.

Analytical results revealed that the highest concentration of pesticide was Atrazine at 27.0 ppm at the zero to six inch depth. Based on the sample findings, AEEI proposed that 3,347 tons of contaminated soil and 454 tons of contaminated gravel would need to be excavated. AEEI calculated that, based on the highest concentration of Atrazine, 89.0 acres of cornfield would be used to land spread the contaminated soil at a rate of 14 to 60 tons per acre.

AEEI then submitted a Land Application of Herbicide Contaminated Soils Permit application to IDOA, which approved the application. The soil was excavated and hauled to the field where it was spread by using a mounted spreader. Part of the soil/gravel mixture was hauled to a landfill and some of the remaining mixture will be spread on farm field roads.

Case Study #14

After a fire occurred at the facility, the Illinois Environmental Protection Agency requested that the owner perform a study and appropriate remediation of the site. The owner selected landfarming of the contaminated soil as a means of achieving site remediation. Soil samples were obtained from the equipment parking area, around the loading area, near the chemical warehouse and from the liquid nitrogen storage tank area.

Analytical results revealed that the highest concentration of pesticide was Alachlor at 20.0 ppm at the zero to six inch depth. Based on sample findings, AEEI proposed that 1,837 tons of contaminated soil would need to be excavated. AEEI calculated that, based on the highest concentration of Alachlor, 145.0 acres of cornfield would be used to land spread the contaminated soil at a rate of 37 to 60 tons per acre and 18.0 acres of soybean field would be used to land spread the contaminated soil at the lower rate.

AEEI submitted a Land Application of Herbicide Contaminated Soils Permit application to IDOA, which approved the application. The soil was then excavated and hauled to the field and spread by a manure spreader.

Case Study #15

Prior to construction of a new containment and load pad facility, an environmental audit was performed by AEEI to determine the extent of any soil contamination. AEEI then obtained soil samples from the proposed facility area.

Analytical results revealed that the highest concentration of pesticide was Alachlor at 1.9 ppm at the zero to six inch depth. AEEI proposed that 1,614 tons of contaminated soil would need to be excavated. AEEI then calculated that, based on the highest concentration of Alachlor, 10.0 acres of cornfield would be used to land spread the contaminated soil at a rate of 60 tons per acre.

AEEI submitted a Land Application of Herbicide Contaminated Soils Permit application to IDOA, which approved the application. The soil was excavated and hauled to the field where it was spread using a manure spreader.

Case Study #16

An investigation by the Illinois Environmental Protection Agency prompted the site owner to seek land spreading as a method of site remediation. AEEI collected soil samples from the load pad area, bermed area that held the surface runoff on site and traffic flow area. Analytical results then revealed that the highest concentration of pesticide was Alachlor 1.59 ppm. Based on these results, AEEI estimated that 3,000 tons of contaminated soil and 250 tons of contaminated gravel would need to be excavated.

AEEI calculated that, based on the highest concentration of Alachlor, 68 acres of cornfield would be used to land spread the contaminated soil at a rate of 30 to 60 tons per acre. AEEI then submitted a Land Application of Herbicide Contaminated Soils Permit application to IDOA, which approved the application.

Case Study #17

In order to assist in the sale of his property, the owner had an Environmental Property Audit conducted to determine the extent of soil contamination. The owner then proceeded with soil remediation at the property. First, AEEI obtained soil samples from areas where the application equipment had been stored, the loading was completed (outside of the herbicide containment area), at the edge of the load pad where vehicle trucks were located, from the west edge of the property (used to determine the extent of contamination coming onto the property) and from the area where surface water drained and stood until the tile allowed it to drain. Samples were also collected from the roadside ditch into which the surface water also drained.

Analytical results revealed that the highest concentration of pesticides was Atrazine at 27.0 ppm at the zero to six inch depth. AEEI then proposed that 1,217 tons of contaminated soil needed to be excavated. AEEI calculated that, based on the highest concentration of Atrazine, 20.0 acres of cornfield would be used to land spread the contaminated soil at a rate of 60 tons per acre.

This site participated in the voluntary cleanup program, so AEEI provided IEPA with interim reports which reported site cleanup progress. Next, AEEI submitted a Land Application of Herbicide Contaminated Soil permit to IDOA which was approved.

At the start of the land spreading, three spreaders pulled by tractors were used. One spreader was a single-axle with a push ram, the second, a double-axle with a push ram, and the third, a double-axle with a chain drive. The chain drive broke early in the spreading; however, the two push ram spreaders worked well. The single axle spreader held three to four tons of soil and the double-axle held five to six tons of soil. The soil/gravel mixture was then hauled to and spread on area field roads.

Case Study #18

A transportation accident involving Treflan occurred when a semi-truck ran off a highway curve. The Treflan either burned or saturated the ground. AEEI collected soil samples around the entire curve area.

Analytical results revealed that the average concentration of Trifluralin was 86.0 ppm. AEEI estimated that 8,230 tons of soil would need to be excavated. AEEI calculated that, based on the concentration of Trifluralin, 733 acres of field soybeans would be used to land spread the contaminated soil at a rate of 13 tons per acre.

AEEI then submitted a Land Application of Herbicide Contaminated Soils permit application to the Illinois Environmental Protection Agency for their review and approval, together with a concurrent review by IDOA. Since this was a transportation accident and was not at an agrichemical facility, it was not eligible for approval by IDOA. Therefore, the project proceeded under the authority and review of IEPA which approved the land application of the soil. The soil was then excavated, hauled to the field and spread using two mounted spreaders and a single-axle manure spreader.

4.0 PROJECT COST INFORMATION ON SIX SITES

4.1 Overview of Cost Summaries

A summary of overall project costs for six pesticide-contaminated sites using landfarming for remediation is included in Table 1. This table is a summary of the costs for each site on a "per ton" basis. As noted in the table, the average total cost for the six landfarming projects is $22 per ton.

An item worth noting is that these costs include the complete project scope from site investigation to closure. Therefore the average costs includes everything from pre-engineering or site assessment costs to the cost of backfill for the excavated soil, as well as the cost for laboratory analysis one year after soil spreading.

TABLE 1: Overall Project Cost Summary of Six Pesticide–Contaminated Sites Using Landfarming for Remediation

Case Study Number	Total Tons Soil	Cost per Ton of Soil	Total Tons Gravel	Cost per Ton of Gravel	Total Cost per Ton
1	4,368	$36	155	$5	$35
2	603	$36	160	$9	$30
3	2,865	$27	–	–	$27
4	2,895	$25	625	$6	$22
5	1,842	$21	280	$5	$19
6	12,960	$17	–	–	$17
Averages	**4,256**	**$23**	**305**	**$6**	**$22**

Tables 2 and 3 show what costs were involved to perform the specific tasks associated with the landfarming projects. Table 2, Total and Average Project Cost Summary, reports costs related to soil and costs related to gravel on a "per site" basis for each task. As shown at the bottom of the page, the average cost for completing the six landfarming sites was $100,445. Table 3, Project Unit Cost Summary, presents the same set of costs for each task, however, these are reported as unit costs on a "per ton" basis. The averages are calculated based on a weighted average of the tons of soils or gravel remediated at each site.

TABLE 2: Total and Average Project Cost Summary of Six Pesticide–Contaminated Sites Using Landfarming for Remediation

On A Per Site Basis

Costs Related to Soil

Case Study No.	Tons Soil	Excavation	Hauling	Loading in Field	Land Rental	Spreading	Backfill	Labor	Farm field Samples	On–site Samples	I/A Testing	Engineering	Total
1	4,368	$8,736	$21,840	$6,552	$4,116	$21,840	$21,840	$7,500	$1,650	$4,050	$3,660	$54,995	$156,779
2	603	$1,809	$1,508	$1,899	$441	$3,015	$3,920	$600	$450	$1,050	–	$7,046	$21,737
3	2,865	$5,730	$7,163	$4,298	$861	$14,325	$18,564	$1,800	$900	$4,650	–	$19,332	$77,623
4	2,895	$4,487	$3,619	$5,877	$3,180	$13,028	$12,192	$1,540	$900	$3,714	–	$23,992	$72,528
5	1,842	$1,842	$5,526	$2,604	$1,260	$9,210	$7,368	$1,200	$750	$1,800	–	$6,942	$38,502
6	12,960	$25,920	$32,400	$19,440	$3,360	$64,800	$51,840	$2,400	$1,350	$3,990	$2,050	$17,134	$224,684
Average	**4256**	**$8,087**	**$12,009**	**$6,778**	**$2,203**	**$21,036**	**$19,287**	**$2,507**	**$1,000**	**$3,209**	**$2,855***	**$21,574**	**$98,642**

* Since immunoassay was utilized at only two sites, the average is calculated based on two sites and not six.

Costs Related to Gravel

Case Study No.	Tons Gravel	Excavation	Hauling	Loading in Field	Land Rental	Spreading	Backfill	Labor	Farm field Samples	On–site Samples	I/A Testing	Engineering	Total
1	155	$310	$233	$233	–	–	–	–	–	–	–	–	$775
2	160	$480	$400	$504	–	–	–	–	–	–	–	–	$1,384
3	–	–	–	–	–	–	–	–	–	–	–	–	–
4	625	$969	$1,300	$1,269	–	–	–	–	–	–	–	–	$3,538
5	280	$280	$840	$395	–	–	–	–	–	–	–	–	$1,515
6	–	–	–	–	–	–	–	–	–	–	–	–	–
Average	**305**	**$510**	**$693**	**$600**	–	–	–	–	–	–	–	–	**$1,803**

Note: Some costs include permitting and handling of both the gravel and soil. However, these costs can not be differentiated. For these costs, the entire amount was allocated to the soil. Therefore, the tables showing costs related to gravel do not represent the complete cost associated with gravel for the four sites which applied gravel on farm field roads.

AVERAGE TOTAL COST PER SITE $100,445

TABLE 3: Project Unit Cost Summary of Six Pesticide–Contaminated Sites Using Landfarming for Remediation

On A Per Ton Basis

Costs Related to Soil

Case Study No.	Tons Soil	Excavation per ton	Hauling per ton	Loading in Field per ton	Land Rental per ton	Spreading per ton	Backfill per ton	Labor per ton	Farm field Samples per ton	On–site Samples per ton	I/A Testing per ton	Engineering per ton	Total Cost per ton
1	4,368	$2.00	$5.00	$1.50	$0.94	$5.00	$5.00	$1.72	$0.38	$0.93	$0.84	$12.59	$36
2	603	$3.00	$2.50	$3.15	$0.73	$5.00	$6.50	$1.00	$0.75	$1.74	–	$11.68	$36
3	2,865	$2.00	$2.50	$1.50	$0.30	$5.00	$6.48	$0.63	$0.31	$1.62	–	$6.75	$27
4	2,895	$1.55	$1.25	$2.03	$1.10	$4.50	$4.21	$0.53	$0.31	$1.28	–	$8.29	$25
5	1,842	$1.00	$3.00	$1.41	$0.68	$5.00	$4.00	$0.65	$0.41	$0.98	–	$3.77	$21
6	12,960	$2.00	$2.50	$1.50	$0.26	$5.00	$4.00	$0.19	$0.10	$0.31	$0.16	$1.32	$17
Average		**$1.90**	**$2.82**	**$1.59**	**$0.52**	**$4.94**	**$4.53**	**$0.59**	**$0.23**	**$0.75**	**$0.33**	**$5.07**	**$23**

Costs Related to Gravel

Case Study No.	Tons Gravel	Excavation per ton	Hauling per ton	Loading in Field per ton	Land Rental per ton	Spreading per ton	Backfill per ton	Labor per ton	Farm field Samples per ton	On–site Samples per ton	I/A Testing per ton	Engineering per ton	Total Cost per ton
1	155	$2.00	$1.50	$1.50	–	–	–	–	–	–	–	–	$5
2	160	$3.00	$2.50	$3.15	–	–	–	–	–	–	–	–	$9
3	0	–	–	–	–	–	–	–	–	–	–	–	–
4	625	$1.55	$2.08	$2.03	–	–	–	–	–	–	–	–	$6
5	280	$1.00	$3.00	$1.41	–	–	–	–	–	–	–	–	$5
6	0	–	–	–	–	–	–	–	–	–	–	–	–
Average		**$1.67**	**$2.27**	**$1.97**	–	–	–	–	–	–	–	–	**$6**

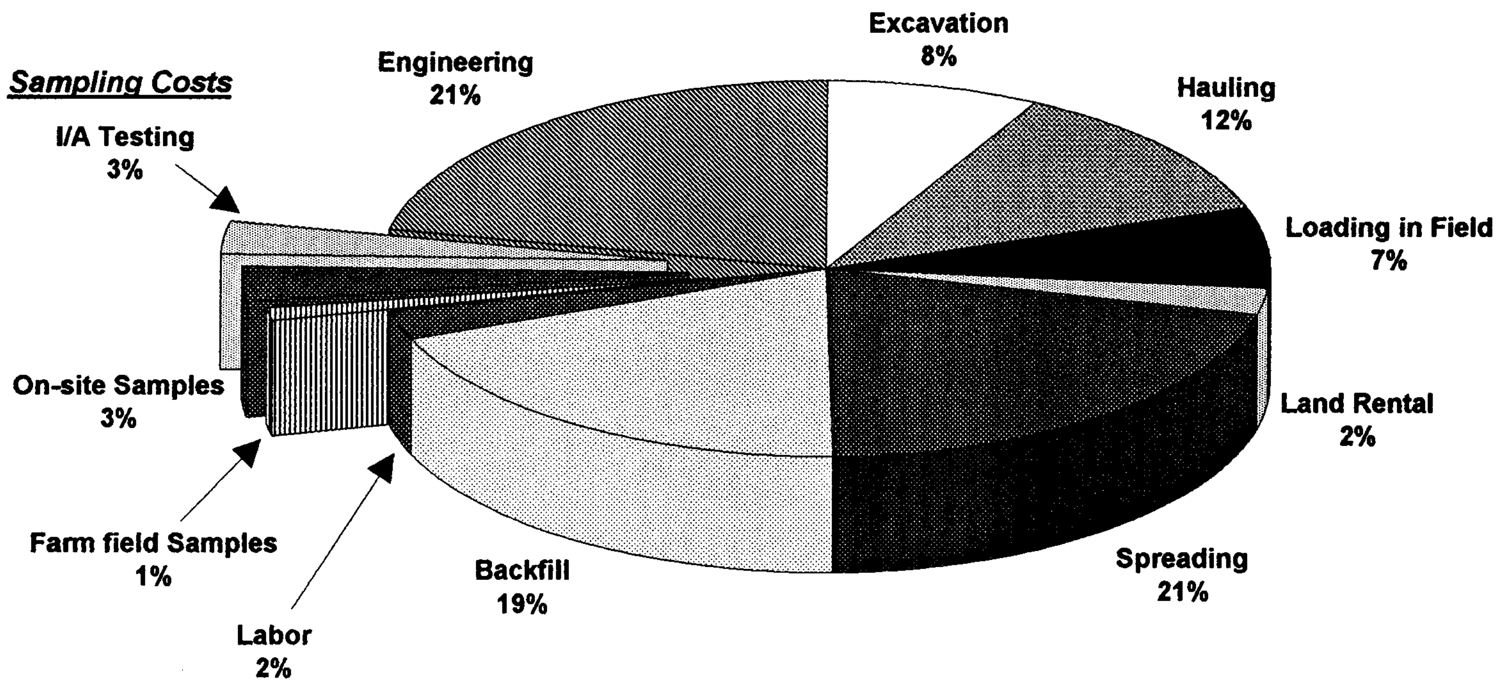
AVERAGE TOTAL COST PER TON $22

4.2 Individual Site Cost Analysis

A pie chart representing the average portion of costs related to specific tasks for landfarming projects is shown in Figure 1, Summary of Total Landfarming Remediation Project Costs for Pesticide-Contaminated Soils. This chart is based on the costs averaged from a case study of six sites. As evident from the chart, the majority of the costs are related to materials handling. This includes excavation, hauling, field loading, soil spreading and backfill. Together these make up approximately 67 percent or two-thirds of the project costs.

Following Figure 1 are Tables 4 through 9, Project Cost Summary and Analysis for Six Pesticide-Contaminated Sites Using Landfarming for Remediation. These tables show landfarming remediation costs broken down into tasks or categories for each individual site. These tables also summarize the amount of soil, gravel and acreage permitted for each site as well as a calculation of the costs.

Figure 1: Summary of Total Landfarming Remediation Project Costs for Pesticide-Contaminated Soils



Note: Average Costs Based on a Case Study of Six Sites

TABLE 4: Project Cost Summary and Analysis for Pesticide–Contaminated Sites Using Landfarming for Remediation

Case Study #1

Estimated tons of gravel – 155
Estimated tons of soil – 4,368

Acres required for soil spreading
Corn: 98.0 Soybean: 0

Tasks	Unit Cost	Soil	Gravel
Preparing Illinois Dept. of Agriculture permit (Engineering)		$3,000	
Soil and gravel excavation	4523 T x $2.00/T	$8,736	$310
Haul soil to field	4368 T x $5.00/T	$21,840	
Haul gravel to field	155 T x $1.50/T		$233
Loading spreading vehicle	4523 T x $1.50/T	$6,552	$233
Farm field rental	98 acres x $42.00/ac	$4,116	
Spreading soil on farm field	4368 T x $5.00/T	$21,840	
Loading and hauling backfill	4368 T x $5.00/T	$21,840	
Labor	300 hours x $25.00/hr	$7,500	
Closure report (Engineering)		$2,000	
Farm field soil samples – Pre: 6 and Post: 5	11 samples x $150/sample	$1,650	
On–site samples – Pre: 11 and Post: 16	27 samples x $150/sample	$4,050	
Site assessment and consultation (Engineering)		$49,995	
Immunoassay (I/A) Testing		$3,660	
GRAND TOTAL		**$156,779**	**$775**
	COST PER TON	**$35.89**	**$5.00**
	COST PER TOTAL TONS	**$34.83**	

TABLE 5: Project Cost Summary and Analysis for Pesticide–Contaminated Sites Using Landfarming for Remediation

Case Study #2

Estimated tons of gravel – 160
Estimated tons of soil – 603

Acres required for soil spreading:
Corn: 10.5 Soybean:0

Tasks	Unit Cost	Soil	Gravel
Preparing Illinois Dept. of Agriculture permit (Engineering)		$1,500	
Soil and gravel excavation	763 T x $3.00/T	$1,809	$480
Haul soil to field	603 T x $2.50/T	$1,508	
Haul gravel to field roads	160 T x $2.50/T		$400
Loading spreading vehicle	763 T x $3.15/T	$1,899	$504
Farm field rental	10.5 acres x $42.00/acre	$441	
Spread soil on farm field	603 T x $5.00/T	$3,015	
Loading and hauling backfill	603 T x $6.50/T	$3,920	
Labor	40 hours x $15/hr	$600	
Closure report (Engineering)		$2,000	
Farm field soil samples – Pre: 1 and Post: 2	3 samples x $150/sample	$450	
On–site samples – Pre: and Post:	7 samples x 150/sample	$1,050	
Site assessment and consultation (Engineering)		$3,546	
Immunoassay (I/A) Testing			
GRAND TOTAL		**$21,738**	**$1,384**
	COST PER TON	$36.05	$8.65
	COST PER TOTAL TONS	$30.30	

TABLE 6: Project Cost Summary and Analysis for Pesticide–Contaminated Sites Using Landfarming for Remediation

Case Study #3

Estimated tons of gravel – None
Estimated tons of soil – 2,865

Acres required for soil spreading:
Corn: 20.5 Soybean: 0

Tasks	Unit Cost	Soil
Preparing Illinois Dept. of Agriculture permit (Engineering)		$3,000
Soil excavation	2865 T x $2.00/T	$5,730
Haul soil to field	2865 T x $2.50/T	$7,163
Loading spreading vehicle	2865 T x $1.50/T	$4,298
Farm field rental	20.5 acres x $42/acre	$861
Spreading soil on farm field	2865 T x $5.00/T	$14,325
Loading and hauling backfill	2865 T x $6.50/T	$18,564
Labor	120 hours x $15/hr	$1,800
Closure report (Engineering)		$2,000
Farm field soil samples – Pre: 1 and Post: 5	6 samples x $150/sample	$900
On–site samples – Pre: 13 and Post: 18	31 samples x $150/sample	$4,650
Site assessment and consultation (Engineering)		$14,332
Immunoassay (I/A) Testing		
GRAND TOTAL		**$77,622**
	COST PER TON	**$27.09**

TABLE 7: Project Cost Summary and Analysis for Pesticide–Contaminated Sites Using Landfarming for Remediation

Case Study #4

Estimated tons of gravel – 625
Estimated tons of soil – 2,895

Acres required for soil spreading:
Corn: 53.0 Soybean:0

Tasks	Unit Cost	Soil	Gravel
Preparing Illinois Dept. of Agriculture permit (Engineering)		$3,000	
Soil and gravel excavation	3,520 T x $1.55/T	$4,487	$969
Haul soil to field	2,895 T x $1.25/T	$3,619	
Haul gravel to field roads	625 T x $2.08/T		$1,300
Loading spreading vehicle	3,520 T x $2.03/T	$5,877	$1,269
Farm field rental	53 acres x $60/acre	$3,180	
Spreading soil on farm field	2,895 T x $4.50/T	$13,028	
Loading and hauling backfill	3,048 T x $4.00/T	$12,192	
Labor	140 hours x $11.00/hr	$1,540	
Closure report (Engineering)		$2,000	
Farm field soil samples – Pre: 3 and Post: 3	6 samples x $150/sample	$900	
On–site samples – Pre: 24 and Post: 11		$3,714	
Site assessment and consultation (Engineering)		$18,992	
Immunoassay (I/A) Testing			
GRAND TOTAL		**$72,528**	**$3,538**
	COST PER TON	**$25.05**	**$5.66**
	COST PER TOTAL TONS	**$21.61**	

TABLE 8: Project Cost Summary and Analysis for Pesticide–Contaminated Sites Using Landfarming for Remediation

Case Study #5

Estimated tons of gravel – 280
Estimated tons of soil – 1,842

Acres required for soil spreading:
Corn: 11.0 Soybean: 19.0

Tasks	Unit Cost	Soil	Gravel
Preparing Illinois Dept. of Agriculture permit (Engineering)		$3,000	
Soil excavation	2122 T x $1.00/T	$1,842	$280
Haul soil to field	1842 T x $3.00/T	$5,526	
Haul gravel to field roads	280 T x $3.00/T		$840
Loading spreading vehicle	75 hours x $40.00/hr	$2,604	$396
Farm field rental	30 acres x $42.00/ac	$1,260	
Spreading soil on farm field	1842 T x $5.00/T	$9,210	
Loading and hauling backfill	1842 T x $4.00/T	$7,368	
Labor	120 hours x $10.00/hr	$1,200	
Closure report (Engineering)		$2,000	
Farm field soil samples – Pre: 1 and Post: 4	5 samples x $150/sample	$750	
On–site samples – Pre: 6 and Post: 6	12 samples x $150/sample	$1,800	
Site Assessment and consultation (Engineering)		$1,942	
Immunoassay (I/A) Testing			
GRAND TOTAL		**$38,502**	**$1,516**
	COST PER TON	**$20.90**	**$5.41**
	COST PER TOTAL TONS	**$18.86**	

TABLE 9: Project Cost Summary and Analysis for Pesticide–Contaminated Sites Using Landfarming for Remediation

Case Study #6

Estimated tons of gravel – None
Estimated tons of soil – 12,960

Acres required for soil spreading:
Corn: 80.0 Soybean:0

Tasks	Unit Cost	Soil
Preparing Illinois Dept. of Agriculture permit (Engineering)		$2,000
Soil excavation	12,960 T x $2.00/T	$25,920
Haul soil to field	12,960 T x $2.50/T	$32,400
Loading spreading vehicle	12,960 T x $1.50/T	$19,440
Farm field rental	80 acres x $42/ac	$3,360
Spreading soil on farm field	12,960 T x $5.00/T	$64,800
Loading and hauling backfill	12,960 T x $4.00/T	$51,840
Labor	160 hours x $15.00/hr	$2,400
Closure report (Egineering)		$2,000
Farm field soil samples – Pre: 1 and Post: 8	9 samples/$150/sample	$1,350
On–site samples – Pre: Herbs, Nitr, Ph	21 samples x $190/sample	$3,990
Site assessment and consultation (Engineering)		$13,134
Immunoassay (I/A) Testing		$2,050
GRAND TOTAL		**$224,684**
	COST PER TON	**$17.34**

4.3 Cost Variability

After analyzing the costs involved with the previously mentioned six sites and the other 12 sites in which AEEI has been involved, it should be noted that several factors can impact each project's cost. One of the largest factors can be the volume or tonnage of soil. Small soil tonnages translate to an overall higher cost per ton since there are fixed costs associated with each project. These fixed costs include: the cost of obtaining written authorization from IDOA and engineering site assessment costs which are necessary to define the problems present at each site. If the site has a small soil tonnage, then there are less tons to apply the fixed costs to, thereby resulting in a higher cost per ton.

Regulatory involvement and/or litigation processes also increase costs. These type of sites tend to have higher engineering site assessment and report preparation costs. This is contrasted by self-directed projects with no regulatory or litigation involvement. The major difference in costs between these two types of sites is higher engineering costs, since additional engineering services are needed for meetings and extra report preparation. Time delays can also increase cost. These delays sometimes occur when decisions are not made solely by one person. When more people are involved in the decision-making process, more time is necessary; therefore there is more expense in completing the project.

When a facility owner is willing to be their own general contractor and use their own employees and equipment to complete the landfarming project, project costs decrease. The wage rate and equipment cost involved for a cleanup can be reduced dramatically if a facility undergoing a cleanup uses its own resources to the maximum extent practicable. However, the cost savings are minimized if the facility attempts to use too small or inadequate equipment for tasks such as excavating, loading and spreading soil.

Costs can also be reduced by avoiding additional equipment mobilizations. AEEI has found that using immunoassay testing to determine the limits of excavation can reduce equipment mobilizations and project costs. When using immunoassay testing, site excavation can be completed more quickly and efficiently. Immunoassay helps accomplish this by providing quick turn around times for sample analysis. Soil samples must be analyzed to determine whether or not additional excavation is necessary. However, when soil samples are analyzed using traditional laboratory analysis methods, the excavation must be put on hold until laboratory results are available which is often three to four weeks later. However, a site can be excavated in one mobilization by using immunoassay. This is in contrast to a particular site which required three additional mobilizations to excavate soil when immunoassay was not available for soil analysis.

4.4 Other Technologies

Common practice in Illinois is to dispose of contaminated soil as special waste in IEPA permitted landfills. This requires a licensed special waste hauler to transport the impacted soil to the nearest landfill that is willing to accept it. Special waste disposal costs commonly range from $20-$25 per ton.

Another alternative to soil disposal is thermal desorption or incineration. There are fewer thermal treatment plants than landfills, therefore transportation costs can be even higher. If a large amount of soil must be remediated, a mobile thermal treatment unit can be brought to the site. This avoids increased transportation costs, however it requires a large amount of space at the site to setup the mobile plant. Thermal treatment costs can expected to be $80-$90 per ton.

Since the costs discussed above are for disposal only, these do not include engineering, sample analysis, materials handling or transportation costs. While transporting soil to a farm field for landfarming still requires a special waste hauler, the farm field is usually within five to ten miles; therefore transportation costs are still lower than landfilling.

When comparing these costs to landfarming the difference is overwhelming. As summarized in Table 3, Project Unit Cost Summary, the average total cost for landfarming is $23 per ton. Given this information, landfarming is a most appealing choice when contemplating cost effective remediation methods.

5.0 PROJECT MANAGEMENT ISSUES

A landfarming project includes several steps which must be considered to ensure its success. Several of the steps which must be considered in every successful landfarming project are discussed below.

5.1 Education of Prospective Users on the Landfarming Process

As with any project or task, its success depends on educating those involved. If persons involved in the landfarming process are not informed and educated on what to expect, then fear and apathy will most certainly cause the failure of the task at hand.

Since communication is the primary key to education, facility owners, managers, employees and landowners must be informed of what to expect during the landfarming process and how it might affect them. Open communication is needed to quickly answer any questions the involved parties might have regarding the landfarming process. Otherwise, these people may receive speculative answers from those who are not informed.

AEEI has found that good information dissemination is essential to successfully completing a landfarming project. Although the landfarming project may come under scrutiny by people who are not paying for the landfarming project, it is important to take the time to be open and honest about what is involved; thereby educating anyone who has questions. This includes anyone from a reporter for the local newspaper or television station to the neighbor living next to the field where land application will occur.

In the long run, much more time and energy will be expended in attempting to complete these projects if the fundamentals of educating all parties about the landfarming process are not met successfully.

5.2 On-site Sampling and Analysis

As previously mentioned, a site assessment is necessary to characterize the pesticides. Pesticide concentrations must be known in order to correctly calculate soil spreading rates. Characterization of the pesticide concentrations can occur by sampling excavated stockpiles or by developing a boring program to collect soil samples at various depths in pre-determined areas.

Soil sample borings taken from a pre-defined area can help estimate excavation volumes by identifying the depths to which the soil should be excavated. AEEI has performed soil borings at several sites. Typically, a site visit is needed to identify potential areas of contamination. This requires speaking to employees and managers in order to find out where and what kind of operations took place on the site, i.e., chemical loading. Runoff areas also need to be identified. These areas can then be defined with boundaries which determine soil boring locations. Several soil borings are taken so samples can be composited to represent the area.

These samples are composited for various depths so that each area may have three composite samples (one for each depth). The sample depths will depend on the depth to groundwater and the equipment used for sampling. AEEI has used drill rigs, post hole diggers, hand augers and backhoes (which dig trenches) to obtain soil samples.

One disadvantage to soil boring sampling is that it does not define the extent of contamination. Although contamination depth is well defined, it is difficult to identify the extent of contamination without a costly sampling program. However, if a specific area and depth is to be excavated, then soil can be excavated and stockpiled on the site if room allows. The stockpile can be sampled by compositing several grab samples in and around the stockpile.

The major consideration during soil excavation is determining when to stop. Soil samples of the sidewalls can dictate this. Immunoassay testing can also be very cost effective in this situation which avoids long turn around times on sample results. This was completed at some locations in which regulatory involvement had identified areas of contamination that had to be removed. Immunoassay testing was performed to determine when excavation should stop. Once immunoassay testing showed that pesticide concentrations were acceptable, confirmation samples were then collected and sent to the laboratory.

One disadvantage to immunoassay testing is that not all chemicals can be analyzed using this method. However, some of the most common chemicals, such as alachlor, atrazine, imazaquin, metolachlor and trifluralin can currently be tested and more test kits are becoming available on a continuing basis.

Sometimes the area of excavation was dictated by the construction of new agrichemical facilities. In order to comply with IDOA Part 255 regulations, several agrichemical dealers were constructing new facilities. Some of these facility owners wanted make sure that they were not constructing on contaminated soil at their site so they would analyze a soil sample from where the building was to be constructed. If pesticide concentrations were found, they would excavate the soil where the new building was going to be constructed and landfarm the soil.

As with any landfarming project there is the concern of spreading soil which might be characterized as hazardous under the Resource and Conservation Recovery Act (RCRA). This is especially of concern at agrichemical facilities since some previously used, now banned, pesticides were once handled at these facilities.

If the soil is believed to contain pesticides, which in high enough concentrations might characterize the soil as hazardous waste under RCRA regulations, it is analyzed for RCRA pesticides prior to landfarming. A soil sample is extracted using the Toxicity Characteristic Leaching Procedure (TCLP) and analyzed for chlordane, endrin, heptachlor, lindane, methoxychlor, toxaphene, 2,4-D and 2,4,5-TP Silvex. If the soil sample passes the TCLP test, then it is not considered hazardous for the analyzed pesticides; landfarming can then proceed according to the written authorization. AEEI's experiences have shown that while total concentrations may indicate a presence, TCLP analysis has never exceeded the RCRA limits for the landfarming sites sampled by AEEI.

5.3 Soil Spreading Rates

Samples of the soil to be spread need to be analyzed for pesticides to determine the soil spreading rate. These samples are analyzed for the active ingredient in the targeted pesticide. The chemicals for which analysis is requested is based on the products handled at the site as well as any chemicals which may have established cleanup objectives for the site. Typically, the analyzed chemicals are registered residual herbicides that are currently used and have been used for several years.

The current IDOA program does not include the authority for IDOA to approve landfarming soil high in nutrients as a result of fertilizer solution spills. Although AEEI did not routinely test for nutrient concentrations in the soil, many of the landfarmed soils most likely had some nutrient concentrations. This is common since most of the landfarming projects involved agrichemical facilities which handle fertilizers as well as pesticides. Also, the agrichemical facilities handle more fertilizers than pesticides on a volume basis; therefore, increasing the likelihood of having fertilizer-related spills.

Soil spreading rates of pesticide impacted soil are based on the manufacturers' printed label application rate for pesticides that are registered under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and the Illinois Pesticide Act (IPA). For each chemical, the spreading rates are determined by evaluating the amount of active ingredient in the soil to be applied and calculating the maximum soil spreading rate without exceeding the label rate for the active ingredient.

This is done by estimating the amount of each chemical present based on the concentration and volume of soil to be spread. The acreage needed to apply each chemical is determined based on its own label rate. The acres for each chemical are then added to determine the rate at which the soil will be spread. This spreading rate must be checked for some special conditions.

Often, the soil will contain a mixture of pesticides. Soil containing herbicides used exclusively on corn acres as well as other herbicides used exclusively on soybean acreage present the problem of spreading soil without damaging the crop to be planted in the field. When soil containing chemicals for both corn and soybean acreage is spread, the effects of non-target crop chemicals must be considered.

If needed, the soil spreading rate is adjusted so non-target crop chemicals are spread at ten percent of their label rate. For example, if a soil sample shows that the major chemical contaminant was atrazine (a herbicide used on corn which will kill soybeans), however the soil also contained trifluralin (a herbicide used on soybeans which will kill corn), the spreading rate for corn acreage would be according to the label rate for atrazine. The spreading rate would then be verified to make sure that trifluralin (the non-target crop chemical) was being applied at ten percent or less of its label rate to avoid injuring the corn. If the non-target crop chemical would be applied heavier than ten percent of its label rate, then the spreading rate would be adjusted so that less soil was applied per acre in order to achieve the ten percent label rate of the non-target crop chemical. Applying non-target crop herbicides at ten percent or less of their label rate will help prevent yield loss of the target crop.

Some herbicide formulations are a mixture of two or more active ingredients. When such combinations are present in the soil, label rates for each active ingredient, when applied together, may be less than the label rate for the active ingredient when it is applied by itself. When possible, the calculated spreading rate is checked against the label rate of these multiple active ingredient herbicide formulations when multiple active ingredients are present in the soil.

5.4 Acreage Selection

Landfarming is dependent upon finding cooperative landowners who are willing to accept pesticide containing soil to be spread on their land. Privately owned facilities normally ask reliable customers or board members if they would be interested in providing land for soil spreading. Facility owners usually rent the land or provide services to the landowner in exchange for using their land. It is important that the cooperating landowners and facility owner have a good relationship. If cooperating landowners trust the facility owner, then the landfarming project will proceed much more smoothly. AEEI found that it was very helpful to meet with the facility owner and several interested landowners to educate them and answer any questions they might have concerning the landfarming process.

Some facilities own farmland which can also be utilized for landfarming purposes. This eliminates the need for contractual agreements. This arrangement also allows more flexibility in the soil spreading operations. For instance, if less acreage is required with the soil being spread on farmland planted to corn, then the crop rotation for the facility-owned land could be adjusted to accommodate for this. A farmer is less likely to change his crop rotation or delay planting in a field to accommodate soil spreading unless there is significant compensation as an incentive to do so.

Some facilities are cooperatives which are owned by stockholders and have an elected board. The cooperative's board members, frequently made up of farmers, are a good source for nearby cooperating landowners who are already knowledgeable about what is happening at the facility site. The board members also have an interest in helping the facility succeed financially so it can provide them with continued service.

Timing is crucial for the landfarming projects. Most of the landfarming projects managed by AEEI have been on acreage to be planted with corn or soybeans. Therefore, the soil has to be spread on unfrozen ground sometime after crops have been harvested in the fall and before crops are planted in the spring. The ground must be dry enough for trucks to move in and out of the fields without getting stuck or causing excessive compaction. With weather dictating the conditions for landfarming, all equipment and personnel must be ready to begin work when the conditions are optimum. Otherwise, it can be difficult to have the soil spread before the crops must be planted.

Another option for obtaining acreage for landfarming purposes is to utilize either Acreage Conservation Reserve Set-aside (set-aside) or Conservation Reserve Program (CRP) acres. This type of farmland can be available for landfarming in the summer when the corn and soybean crops have already been planted. The state CRP enrollment report shows contracts established to date include 822,130 acres in vegetative cover, grass or trees. The 1992 set-aside enrollment report shows that the total number of producers enrolled in 1992 were 84,412 with 10,074,915 acres in the set-aside program from all eligible bases. Increasing set-aside and CRP acreage would be advantageous in allowing additional acreage for landfarming soil. Any facility wanting to use set-aside or CRP acreage must apply for approval before proceeding.

5.5 Operational Control Practices

The following operational control practices were used in AEEI's landfarming projects to ensure that pesticides in the soil did not pose a pollution hazard for surface or groundwater or create crop damage.

<u>Setbacks</u>
Soil application should not be allowed within 20 feet of the field's edge, 200 feet of any occupied dwelling or 20 feet from any field drainage ditch or grass waterways. Soil survey maps are used to assist in determining soil types and slope ranges where soil application will take place.

<u>Slope</u>
Landowners, who use conservation tillage or conventional tillage systems and allow soil application on their land, can have soil application on slopes of five percent or less. Landowners, who have developed conservation plans that meet the Universal Soil Loss Equation approved by the U.S. Department of Agriculture, Soil Conservation Service, can have soil application on all upland soil types.

<u>Floodplain</u>
Soil application may not occur on land that has a flood return frequency of ten years or less.

5.6 Spreading Techniques

Since the soil structure and consistency varies throughout the state, several types of equipment have been tested to provide adequate and uniform soil spreading. This spreading equipment includes manure spreaders of varying sizes. Heavy duty, tandem axle manure spreaders provide the best results for soil spreading using a manure spreader. Modified dry sewage sludge spreader boxes mounted on high floatation application equipment have also been used successfully in providing uniform coverage down to eight tons of soil per acre (Figures 2 and 3).

The soil spreading works best when the soil is drier. Excavation depths below five to six feet frequently result in wet soil that is more difficult to spread. Subsoil with high clay content also increases the difficulty of spreading the soil uniformly. Sandy soil is fairly easy to spread.

Depending on the soil type, soil can be spread from eight tons per acre to sixty tons per acre in one pass. Higher spreading rates can be obtained by completing multiple passes with the equipment. However, soil compaction can become a problem, resulting in yield loss.

After the soil is hauled and stockpiled in the fields, it is loaded with a front-end loader. A large size front-end loader is best when used to fill mounted spreading equipment because of the height. A track-hoe has also been used to load the modified sludge spreader. Although it may take a little longer to fill the spreading vehicle, the track-hoe can place the soil in the spreader box more uniformly, which is necessary when the soil spreading rates are low.

5.7 Farm Field Sampling and Analysis

AEEI has developed a sampling and analysis plan which is now included in every land application. This plan provides adequate data on the farm fields to document the pesticide concentrations before and after soil spreading while still being cost effective for the landfarming client. Some considerations addressed in this plan are general sampling procedures, closure sampling requirements and quality assurance/quality control. Regarding the sampling and analysis plan, one consideration for post soil spreading field sampling is to use immunoassay testing. This provides adequate data to analyze the pesticide concentrations while still being cost effective. Since the accuracy of sample results is not critical in this situation, immunoassay testing could be utilized instead of traditional laboratory testing. The sampling and analysis plan is provided below.

Sampling and Analysis Plan for Land Application of Herbicide Containing Soils

Introduction

This plan provides procedures for the sampling and analysis associated with the land application of herbicide containing soils. The soils will be land applied according to a land application permit issued by the Illinois Department of Agriculture (IDOA) and under the statutory authority created by Public Act 86-1172.

Sampling and Analysis Objectives

The sampling and analysis program for a land application field is structured to show that the herbicides contained in the soil have significantly degraded over a growing season and the farm field is left with herbicide concentrations no greater than were present prior to land application. The sampling and analysis provide for the evaluation of background concentrations of selected herbicides in the application field's soil prior to land application. Closure samples of the farm fields will be taken approximately one year after application of the herbicide containing soils to confirm that no residual herbicide concentrations are present above the background concentrations.

Analytical Methods

Herbicide containing soil samples will be analyzed for nine common herbicides. These herbicides (Alachlor, Atrazine, Cyanazine, Metribuzin, Metolachlor, Pendimethalin, Simazine, and Trifluralin) will be analyzed using SW-846 Method 8141.

General Sampling Procedures

Each soil sample will consist of grab samples placed in a decontaminated galvanized bucket using a clean hand trowel and mixed to provide a composite sample representative of the area. After the sample is collected and mixed, it will be placed in a clean, glass jar with a Teflon® lined-lid. The jars will be labeled, placed in coolers, cooled with "blue ice," and shipped under chain of custody to a laboratory.

Trowels and buckets will be decontaminated before collecting each sample by washing all surfaces with potable-quality water and an alkaline detergent. The equipment will be rinsed with potable quality water and then rinsed again with a methanol and distilled water mixture. The equipment will be given a final rinse using distilled water.

Background Sampling

Prior to the land application of soils, the farm fields will be analyzed to establish background concentrations for selected herbicides. The number of samples collected will be equal to one composite sample of five to ten grab samples for each land application field. Any background concentrations will be considered in the evaluation of residual herbicide concentrations present one year after land application.

Closure Sampling

Approximately one year after land application of the herbicide containing soils, samples will be taken from the land application fields. The number of composite samples collected will depend on the size of the field. For fields up to 20 acres in size, the field will be divided into quadrants and a composite sample will be collected from each quadrant providing four samples. Fields larger than 20 acres will be divided into five-acre square grids approximately 467 feet long on each side. Four composite samples will be collected from randomly selected five-acre squares in fields up to 80 acres in size, representing no less than 25 percent of the five-acre grids. Fields larger than 80 acres will have 25 percent of the five-acre squares randomly sampled. The five-acre squares will be sampled by dividing the square into quadrants and compositing a grab sample from the four quadrants. The number of composite samples for each field will be determined by multiplying the number of five-acre squares by 25 percent and rounding to the nearest whole number.

The sample locations will be determined by assigning consecutive numbers to each five-acre square. The five-acre square can only be counted if fifty percent or more of the field makes up its area. A series of random numbers will be generated using a computer spreadsheet program. The numbered five-acre squares that correspond to the random numbers will be sampled until the required number of samples are obtained.

This sampling plan is designed to statistically represent herbicide concentrations in the land application field by sampling no less than 20 percent of the five-acre squares in a field larger than 80 acres. Herbicide analysis can become costly for large fields since the cost for herbicide analysis is approximately $150 for each sample.

TABLE 10: Sample Number Determination

Application Area *(Acres)*	Number of Five Acre Squares	Number of Samples
5	N/A(1)	1
10	N/A(1)	2
15	N/A(1)	3
20	N/A(1)	4
40	8	4(2)
60	12	4(2)
80	16	4(2)
100	20	5
120	24	6
140	28	7
160	32	8
A	N=A/5	S=N/4

(1) Five-acre squares are not used for application fields 20 acres or smaller. A composite sample is taken for every five acres.
(2) A minimum of four samples are to be collected for application fields larger than 20 acres and less than 80 acres. Otherwise, the number of five-acre squares are multiplied by 25% to determine the number of samples to take.

The laboratory results will be evaluated to determine the mean concentration and standard deviation of the sample. The value of concentrations reported as present but below the detection limit will be used in the calculations. A value of zero will be used for results that are reported as non-detectable. The laboratory results, mean concentration, and standard deviation will be included in the closure report to IDOA.

Quality Assurance/Quality Control

Analysis of the samples for the landfarming project will be performed by a certified laboratory. The laboratory will operate under a Quality Assurance/Quality Control Program. The laboratory will also analyze control samples (including duplicate control samples, single control samples, and method blanks), matrix spikes, matrix spike duplicates, surrogate recoveries, and standard additions to document the performance of the laboratory and the effects of the sample matrix on the analyses. The frequency of the quality control analysis depends on the method requirements or specific contract conditions.

5.8 Contract Agreements and Yield Loss Compensation

An agreement is usually signed by the landowner and facility owner/manager. This agreement provides the approximate number of tons to be spread and the needed acres of farmland. The agreement usually contains a provision to compensate the owner for any yield loss resulting from spreader-vehicle compaction or soil spreading. Field-wide loss is determined by comparing the yield from the landfarmed acres with the yield from the check strips which are located and designated by the agreement. If a yield loss occurs, the total number of decreased bushels can be multiplied by the cash price of the three closest elevators to the facility. The length of the agreements is typically for one growing season with yield loss protection extended to include the following crop year, depending on whether the soil was applied in the spring or fall. The major concerns for farmers are yield loss, compaction or herbicide carry over.

Contracts with the landowners often include statements protecting the owner from yield loss as a result of the landfarming operations. However, none of the projects approved by IDOA in this report have resulted in any significant yield loss. A transportation related accident involving Trifluralin did cause yield loss in soybean fields the year after spreading occurred.

Compaction is less of a problem when the soil can be spread in the summer or fall before planting. The soil is spread at a label rate for the most limiting herbicide. This is comparable to the application rate applied by agrichemical dealers or the farmers.

Heavy trucks will be in and out of the field to stockpile the soil at various locations along the edge of the field. The spreading vehicle will then pull up next to a stockpile to be loaded by a front end loader or track hoe. These high traffic or operational areas will undoubtedly undergo compaction and suffer some yield loss.

Since it is impossible to spread soil with complete uniformity, the growing crop may suffer the affects of phytotoxicity. This only happens when pesticide concentrations in the soil are high and a large amount of soil happens to get applied in one location so that chemical concentrations in the soil around the plant are too high for it to grow.

Although the soil may have been spread at or below label rates for the herbicide, the plant only realizes the effects of the chemical environment immediately around it.

Due to high chemical concentrations and inconsistent soil application, the pesticide may not degrade completely prior to the growing season for the crop following the year of landfarming. Carryover from pesticides applied the previous year can also cause yield loss. In corn-soybean rotations, this can cause problems due to the effects of pesticides on non-target crops. If chemical carryover is suspected, it may be necessary to postpone the routine crop rotation so that the same crop is planted two years in a row to avoid the carryover effects.

6.0 RECOMMENDATIONS

6.1 Continuation of Authority for Soil Application

On July 13, 1990, House Bill 3649 was signed into law. At Chapter 5, paragraph 819, Section 19, the following new provision was created:

> As part of the consideration of cost effective technologies pursuant to subsection 8 of the Section, the Department may, upon request, provide a written authorization to the owner or operator of an agrichemical facility for land application of pesticide contaminated soils at agronomic rates. Such authorization shall prescribe appropriate operational control practices to protect the site of application and shall identify the site or sites where such land application will take place. No authorizations may be provided by the Department after July 1, 1992. The Department shall periodically advise the Interagency Committee regarding the issuance of such authorizations and the status of compliance at the application sites.

This bill has been extended until July 1, 1995.

As supported by the facts provided on the landfarming projects managed by AEEI and discussed in this report, landfarming can be a successful solution to remediating pesticide containing soils. The landfarming process has proven to be an extremely cost effective technology while providing sufficient operational control practices to protect the application sites.

With appropriate supervision and professional management of the landfarming projects, this technology can be a safe solution to soil remediation while saving millions of dollars in disposal costs. This cost savings will encourage those seeking to remediate pesticide containing soils to proceed with remediation, thereby resulting in more participation as well as reducing environmental risks associated with pesticide contaminated sites.

With these considerations in mind, it is recommended that IDOA be granted permanent authority regarding the land application of pesticide containing soil.

6.2 Application Rate Controls

Although adequate pesticide degradation can occur in pesticide containing soil that is applied heavier than label rates, soil applied at the pesticide label rates allow the chemical to be used as the manufacturer intended. Many pesticide manufacturers formulate their products with a safety margin built-in. In other words, the product's label rate is adequate to provide pest control, however it is not toxic to the target crop until concentrations greatly exceed the label rate. This allows for some margin of error during application so there is no significant yield loss if pesticide application is not entirely uniform.

When landfarming pesticide containing soils, some soil types spread more uniformly than others, therefore pesticide concentrations can vary throughout the field. Spreading soil at the pesticide's label rate minimizes the chance of significant yield loss.

Based on AEEI's experiences with eighteen landfarming projects, it is recommended that the application rate of pesticide containing soils continue so that the soil is spread no heavier than what is allowed according to the label rates of the pesticide's manufacturer. This will ensure the continued success of avoiding significant yield loss and environmental effects which might occur from runoff.

6.3 Operational Area Controls

Pesticides are applied to almost every agricultural field. Although the pesticides must be applied according to the manufacturer's instructions on the label, there is no regulation that prohibits pesticide application on fields in floodplains. The land application of pesticide containing soil is merely applying pesticides to farm fields as most farmers do every growing season. However, soil is used as the carrying medium for the pesticides when land applying as opposed to water when a farmer sprays his field.

AEEI's experiences have found that it is sometimes difficult to determine if farm fields are in a 10-year floodplain, which is currently required for land application. This is difficult to determine since most flood maps are based on a 100-year floodplain. While it would be unrealistic to restrict land application of pesticide containing soil to fields outside of the 100-year floodplain, a better criteria for determining whether land application can occur in low areas is needed. Since there are limited restrictions on allowing pesticides to be sprayed on farm fields located within flood plains, it is inconsistent to provide such restrictions when applying soil containing pesticides to farm fields.

To be consistent with application of pesticides to farm fields, it is recommended that land application of pesticide containing soils be allowed on farm fields according to label rates, as previously authorized. However, to also provide clearer criteria when determining if soil can be applied to farm fields inside 100-year flood plains, it is recommended that land application be allowed on farm fields that have a flood return frequency of two years or more. This will be based on prior knowledge by the landowner and/or previous landowners and documented in the permit application.

6.4 Sampling and Analysis Plan

Depending on the soil spreading rate, several acres can be required to complete a landfarming project. Since samples of the farm field are required before and after soil application, laboratory costs can add up quickly. These costs could soon make landfarming no longer cost effective if too many soil samples are required to certify that the pesticides have degraded. While more data gives a better representation, the analytical requirements need to be kept to a minimum in order for landfarming to be cost effective. It is therefore recommended that field sampling requirements be no more than currently required.

Several samplings are required during the landfarming process. The soils to be land applied need to be analyzed for pesticide concentrations so application rates can be determined. Farm fields also need to be analyzed for those same parameters before and after the soil has been applied to the field. Based on AEEI's experiences with remediation of many agrichemical sites who have spent thousands of dollars in laboratory analytical costs, the pesticides commonly found in the soil at agrichemical facilities involved in remediation can be narrowed to a list of eight to ten pesticides. Many laboratories can analyze one or all of these parameters for one fee.

Those seeking authorization for land application of pesticide containing soils should research the site and be informed of chemicals used at the site under remediation. In many cases, several pesticides should be analyzed, not just one or two. While each analysis should be based on a thorough research of activities and products stored at the site, a standardized initial analytical list could help ensure that all pesticide concentrations have been considered when determining the soil application rates. Therefore, it is recommended that the initial laboratory analysis for landfarming authorization applications be standardized to include analysis of the following herbicides: alachlor, atrazine, cyanazine, metolachlor, metribuzin, pendimethalin, simazine and trifluralin. However, if knowledge of a specific chemical spill exists, chemical(s) should be added to the list previously mentioned, if not already included.

Also in order to adequately document that the soil to be land applied is non-hazardous, it is recommended that each applicant analyze the soil for RCRA pesticides and herbicides using the Toxicity Characteristic Leaching Procedure (TCLP). It is also recommended that laboratory analysis include nitrogen and phosphorus for reasons which are discussed below.

6.5 Continuation of Authority for Water Application

Treating contaminated water is very costly since most pesticides are composed of organic compounds. Carbon filtration is commonly used to remove pesticides from the water which is a very expensive method of remediation of pesticide contaminated water, as AEEI experienced. Groundwater must be filtered for solids and the system must be constantly monitored so the carbon filters can remain effective. All of this translates to small volumes of water being treated at a high cost. Plus there is the question of what to do with the expensive carbon filters when the treatment process is terminated. The pesticides have been concentrated; therefore, the filters often have to be handled as hazardous waste, making the treatment process even more costly. These carbon filters can either be recycled or disposed of; however, either way the pesticides are re-concentrated and most likely will be buried in a landfill.

Land application of pesticide containing water is a cost effective solution that can be used to remediate groundwater. Recovery wells to remediate groundwater could provide agrichemical facilities with makeup water for their business or the water could be piped to a nearby irrigation system. Land application through an irrigation system is beneficial to the crops since it provides both precipitation and pest control. The irrigation system would be designed to spray the groundwater in a misty-drizzle spray so the sun would degrade the pesticides as they are applied to the fields and evaporation of the water is minimal.

A recovery well for remediating groundwater can treat groundwater from a large area and provide large volumes of water by pumping at a rate of 1,000 gallons per minute. After pesticide containing soils are removed from a site, recovery wells can effectively remediate the groundwater if it is impacted. This system will be the least costly, not damage soil or crops and treat more groundwater more quickly than other treatment methods. Therefore, it is recommended that IDOA be given permanent authority to allow land application of pesticide containing water through either agrichemical spraying applicators or irrigation systems. However, since irrigation systems have not been tried, care should be taken to develop operational controls to prevent contamination of the groundwater below the application field.

6.6 Authority to Landfarm Gravel and Rock

Most agrichemical facilities have gravel roads and approaches to loading pads and buildings on their property. The gravel or rock will, at times, contain pesticides from spillage or surface drainage from previous operational practices prior to the containment regulations. This gravel must be removed prior to excavating the contaminated soil. However, the gravel cannot be spread on farm fields since this would damage the soil spreading equipment, as well as, the farmer's equipment. Additionally, farmers do not want rocks in their fields.

A logical solution for pesticide containing gravel disposal is to spread it on field roads within a farm field. Gravel improves the durability of farm field roads while providing pesticide control along the road. The pesticides degrade as they would if applied in the farm field next to the field road. Therefore, it is recommended that this gravel/rock be considered eligible for landfarming on farm field roads, if laboratory analysis shows that it is non-hazardous.

6.7 Authority to Landfarm Fertilizer and Nutrient Impacted Soil and Water

Since most of the landfarming projects involved are agrichemical sites, these sites handle fertilizers as well as pesticides. Typically these sites handled fertilizer products in much larger quantities than pesticides. Therefore, if the site has pesticide contaminated soil, it is more than likely, that the soil also contains fertilizers. Since it is also likely that some pesticide containing soils which have already been land applied also probably contained some nutrients or fertilizers, then the land application of fertilizer and nutrient impacted soil has already taken place.

The landfarming requirements could include some criteria, such as previously promulgated by IEPA for livestock waste and sewage sludge. Although, in general, the requirements should be similar for fertilizer or nutrient soils as those for pesticide soils. The application rates can be easily determined. For instance, the concentrations of nitrate and ammonia in the soil can be used to calculate a spreading rate that will not exceed the crops useful value of the fertilizer in the soil to be spread. For example, if the nitrogen concentration is known, the spreading rate can be calculated so no more than 180 pounds of nitrogen would be applied per acre.

The land application rates of soil and water containing both pesticides and fertilizers is easily determined. The soil application rate is controlled by whichever rate is the most limiting, the pesticide or fertilizer. Therefore, it is recommended that IDOA be granted authority to allow landfarming of soils and water impacted by fertilizer/nutrients. This should be provided so that IDOA can approve the land application of soil or water containing fertilizers/nutrients only or fertilizers/nutrients and pesticides combined.

6.8 Authority for Soil and Water Application from Transportation-related Accidents

Since agrichemicals must be transported to agrichemical facilities for distribution, it is not uncommon to have a transportation accident involving these chemicals. Since transportation-related agrichemical spills are no different than operational-related spills at an agrichemical facility, landfarming of soil or water from these sites should be available as a cost effective remediation technique.

While IEPA has provided authorization to do this in the past, consistency should be maintained. IEPA should still be responsible for the emergency response portion of the accident. However, since authority for land application of pesticide contaminated soil is already in place with IDOA, the permitting requirements should remain consistent related to the landfarming program. Therefore, it is recommended that IDOA be given authority to approve the landfarming of pesticide and/or fertilizer/nutrient contaminated soil from transportation-related accidents that do not occur at agrichemical facilities.

6.9 Closing Remarks

Since inconsistency can result in confusion and therefore failure, the landfarming programs should be administered with coherence. This will also result in congruous management and adequate protection to the application sites and surrounding environment. Given the success of the landfarming program, IDOA should be granted permanent authority to administer a complete landfarming program that incorporates all of the recommendations noted above.

If IDOA were to continue providing the authority for just land application of soils and IEPA were responsible for land application of water, this would be counterproductive in trying to maintain landfarming as a successful remediation technique. If necessary, a joint review, could be used at first. However, there should still be a standardized process for all landfarming projects related to agrichemicals.

A comprehensive landfarming program for soil, gravel and water impacted by agrichemicals is a productive remediation alternative which will encourage participation by those who can understand and utilize the program. This will distinguish the State of Illinois as a state which is dedicated to safe and cost-effective ways of cleaning up and protecting the environment.

Figure D-1: An end loader fills the box of the modified sludge spreader prior to starting another round of soil spreading.

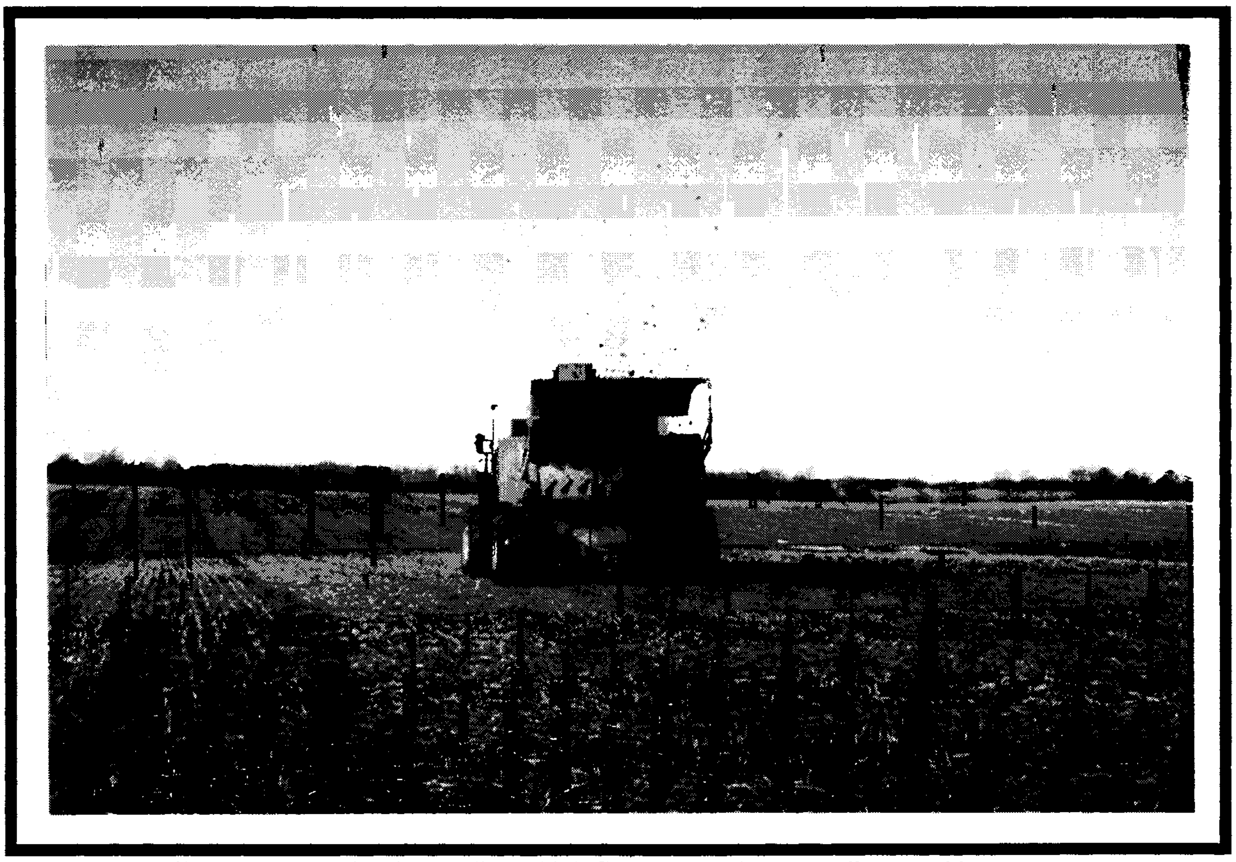


Figure D-2: Soil being spread by the modified high flotation sludge spreading machine.

Figure D-1: An end loader fills the box of the modified sludge spreader prior to starting another round of soil spreading.

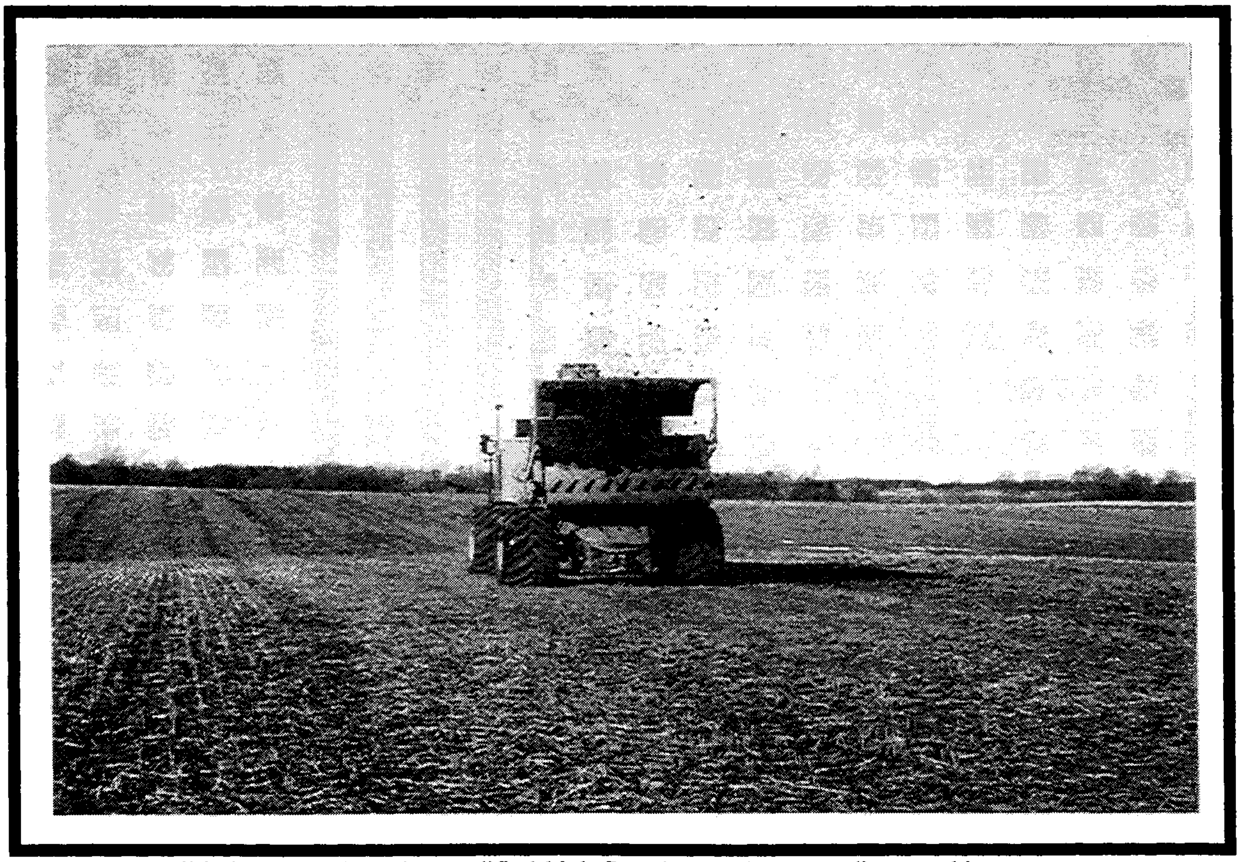


Figure D-2: Soil being spread by the modified high flotation sludge spreading machine.

Figure 2: An end loader fills the box of the modified sludge spreader prior to starting another round of soil spreading.

Figure 3: Soil being spread by the modified high flotation sludge spreading machine.

Figure D-1: An end loader fills the box of the modified sludge spreader prior to starting another round of soil spreading.

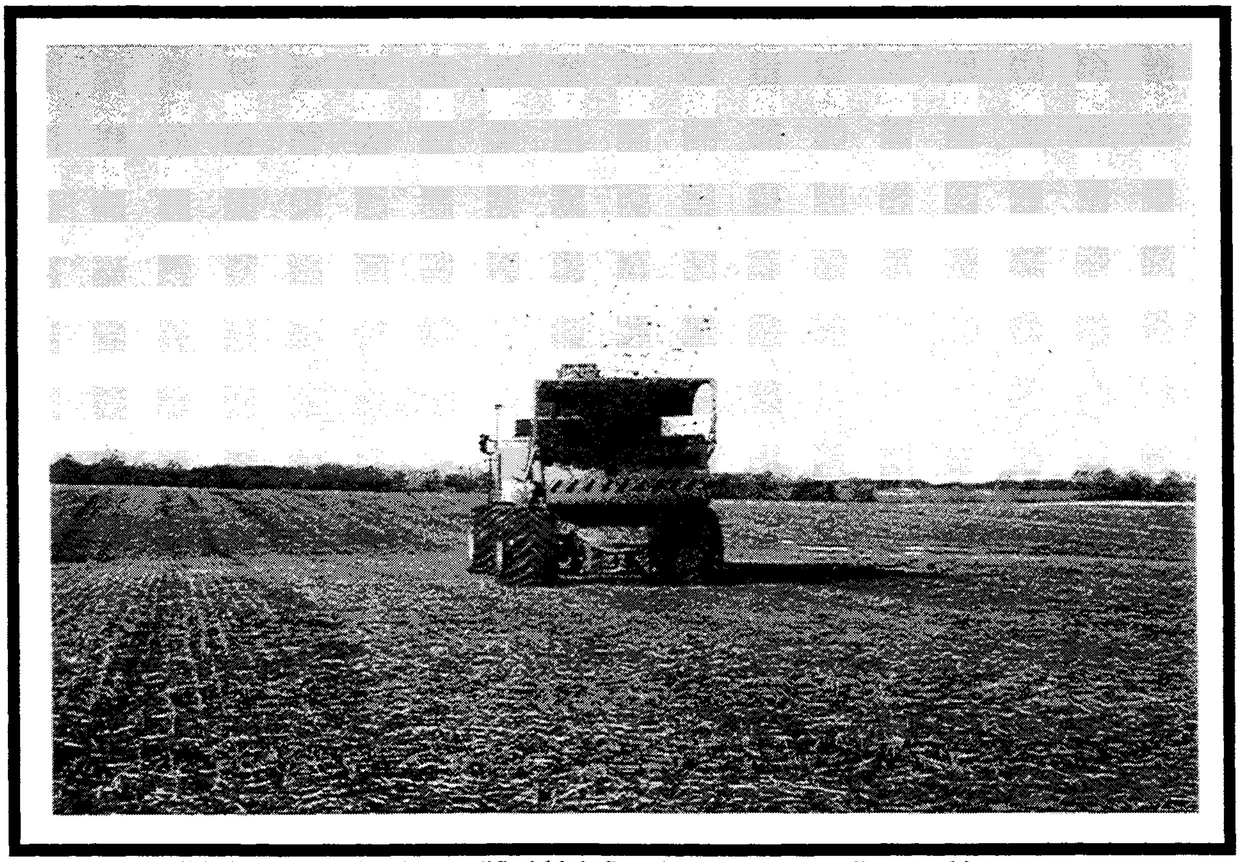


Figure D-2: Soil being spread by the modified high flotation sludge spreading machine.