Approved: January 27, 1998
Date

MINUTES OF THE HOUSE COMMITTEE ON AGRICULTURE.

The meeting was called to order by Chairperson Joann Flower at 9:00 a.m. on January 21, 1998, in Room 423-S of the Capitol.

All members were present except: Representative Compton - excused
Representative Lloyd - excused

Committee staff present: Raney Gilliland, Legislative Research Department
Gordon Self, Revisor of Statutes
Kay Scarlett, Committee Secretary

Conferees appearing before the committee:
Patrick Lais, President, York Pharmaceuticals
John Bullington, President and CEO, FIFCO INTERNATIONAL, INC.
Scott Westlake, President, Enviro-Lab, Inc.
Kent Misemer, Chairman and CEO, Propane Continental, Inc.
Travis Herman, York Pharmaceuticals

Others attending: See attached list

Chairperson Flower asked for requests for introduction of committee bills. There were none. Representative Ballou introduced representatives of Recoverable Resources: Patrick Lais, owner; John Bullington; Scott Westlake; Kent Misemer; and Travis Herman.

Patrick Lais, owner, Recoverable Resources, addressed the committee explaining that they are a new Limited Liability Corporation formed for the sole purpose of addressing animal waste problems. He said that Recoverable Resources brings together a group of individuals that have vast knowledge of microbial products, the animal agricultural industry, and business. He explained that Section 2 of their written testimony contains a copy of a report dated December, 1997, concerning "Animal Waste Pollution in America: An Emerging National Problem" that was compiled by the Minority Staff of the US Senate Committee on Agriculture, Nutrition, and Forestry for Senator Tom Harkin. Senator Harkin introduced the Animal Agriculture Reform Act on October 28, 1997, calling for national environmental standards for handling of animal waste. Mr. Lais said that it is the opinion of Recoverable Resources management that there will be Federal legislation down the road and that Enviro-Guard can and will assist the producer in obtaining satisfactory results in the handling of animal waste. He said that it is the intention of Recoverable Resources to solve the animal waste problem, but the speed at which their project moves forward will depend on capital, time, and educational support from academia, government, and trade associations. (Attachment 1)

John Bullington, a biochemist, explained the use of Enviro-Guard in the removal of odors and reduction of sludges in lagoons. He said that Bac-Terra, the parent product of Enviro-Guard, is a very complex combination of naturally occurring micro-organisms. Section 3 of their written presentation explains microbial treatment in detail and includes a summary of various studies using Bac-Terra to treat problems in sewage, hog lagoons, and slaughter facilities. He reported that tests have shown that Enviro-Guard is safe, non-toxic, and can be applied at various stages of the operation. He said that Section 4 sets forth the test protocol that Recoverable Resources will use to test Enviro-Guard on animal waste at various hog, cattle, poultry, and slaughter facilities. Mr. Bullington indicated that results of field trials would be known almost immediately, probably less than two weeks, and estimated the cost of using Enviro-Guard at 50 cents a head for the life of the animal.

Chairperson Flower stated that the committee was interested in gathering all the facts and hearing from various groups concerning confined animal waste pollution. She said that if anyone knew of someone they think the committee should hear on this issue, to contact either herself, Representative Ballou, or Representative Weiland.

The meeting adjourned at 9:55 a.m. The next meeting is scheduled for January 22, 1998.

Unless specifically noted, the individual remarks recorded herein have not been transcribed verbatim. Individual remarks as reported herein have not been submitted to the individuals appearing before the committee for editing or corrections.

HOUSE AGRICULTURE COMMITTEE GUEST LIST

DATE: January 21, 1998

NAME	REPRESENTING
Mike Jensen	Ks Pork Council
Scott Westlake	Natural Products Int'l
JOHN BULLINGTON	NATURAL PRODUCTS INT'L
Jim Allen	Seaboard
Travis Herman	York Pharm.
PAT LAIS	York Pharmaceuticals
John D. McClure	
Kerri Ebert	KS Dairy Association
Marty Vanier	KS Ag Alliance
Diane Gruner	Ks Coop Council
Jeff Arpin	Division of the Budget
Carole Jordan	Ks Dept of Ag
Derenda Mitchell	" " " "
Rich McKee	KLA
Sue Kissinger	Harris News Service
Dan Thalmann	National Audubon Soc.

STATE OF KANSAS

and

Recoverable Resources

"A Company dedicated to solving the animal waste problem in America"

January 21, 1998

House Agriculture Committee
January 21, 1998
Attachment 1

January 21, 1998

John Ballou
Representative Forty-Third District
Johnson County
State Capitol Room #427-5
Topeka, KS 66612-1504

Dear John:

We first wish to thank you for allowing us the opportunity to come to Topeka to meet with you and your constituents. We are all keenly aware of the problems facing animal agriculture today and in the future. It is our belief that if industry, academia, the producers and the government all work together that we can solve the ever growing problem.

Agriculture in America is of paramount importance to us all, both domestically ad internationally. The company that we are forming is dedicated to solving the animal waste problem. It is with your help that we have taken a step in succeeding with our goal.

Again, thanks to you for orchestrating this meeting and taking the time out of your busy schedule to meet with us.

Sincerely,

Patrick J. Lais

Agenda

I. Introductions

II. Animal Waste Pollution Summary

III. Microbial Treatment/Solution

   a. How does Enviro-Guard work

   b. Summary of results

   c. Ease of Application

   d. Economics of our Enviro-Guard

IV. Protocol requirements for further testing of Enviro-Guard

V. Potential for State, Federal, Trade Association or Producer support

INTRODUCTION

Recoverable Resources

This Limited Liability Corporation is being formed for the sole purpose of addressing the Animal Waste problem in America today. The consolidation that has occurred in animal agriculture has exasperated this problem by condensing the number of animas raised per acre. The United States will continue to focus on agriculture because of the importance both domestically and for export.

The sophisticated corporate farms have the ability to be least cost producers and the ability to enter the world market. But these same corporate farms are the ones that will face increased pressure from the public and the government.

Recoverable Resources brings together a group of individuals that has vast knowledge of microbial products, the animal agriculture industry and business.

John Bullington –

Mr. Bullington is the President and CEO of FIFCO INTERNATIONAL, INC., a Biotechnology firm which is the exclusive manufacturer for Bac-Terra (various microbial blends of beneficial bacterial products) with distribution worldwide.

He began working with metallurgical and biological chemistry in 1978, where his research experimentations combined various beneficial biological cultures enabling nature to perform tasks with minerals, which men were performing mechanically, with only limited success. Over the next ten years, Mr. Bullington relentlessly tested, modified, re-tested, and proved various microbial blends (combining natural bacterial cultures from many different geographical areas) to enhance soil, water, and plant development as well, by accelerating the breakdown of organic matter in the soil.

Many of his discoveries were so dramatic, that he founded FIFCO INTERNATIONAL, INC. in 1988 in Del Mar, California, where he developed the related technology for Bac-Terra applications. This company embarked on two years of extensive "in-field" testing of his various microbial blends (Bac-Terra) throughout the United States and several foreign countries. Testing proved these specific combinations of natural resources can do many things which are otherwise "impossible!"

Mr. Bullington continues to serve as the Chief Executive Officer, Chairman of the Board, and majority stock holder of FIFCO INTERNATIONAL, INC., where he continues developing and perfecting biological blends of microbial products designed to combat problems plaguing our environment.

Scott Westlake –

Mr. Westlake is currently President of Enviro-Lab, Inc., an environmental remediation company, specializing in the use of Bac-Terra (all natural microbial products) for the clean up of soil and ground water contamination and wastewater treatment. Enviro-Lab also provides environmental audits for real estate transactions. Mr. Westlake previously was President of Westlake Hardware, a Midwest based chain of retail outlets.

Mr. Westlake has personal experience in the clean up of petroleum hydrocarbons in soils and ground water. He was Project Manager in the bio-remediation of a 1,000 cubic yard site near Lee's Summit, Missouri. Treatment consisted of both in situ and land farming. The site was remediated to meet state requirements within 30 days after treatment using Bac-Terra products.

Kent Misemer –

Mr. Misemer is Chairman and Chief Executive Officer of Propane Continental, Inc. He has experienced the all-inclusive responsibilities of a start-up company that has become a $120 million corporation, of which he is the head. At 48 years old he has had a high level of management responsibilities. He is not only an effective leader, but is a very active participant in the primary activities of the Company, with primary focus on the funding and acquisition efforts. Mr. Misemer possesses the fundamental strengths of being able to attract and hold quality people. In addition to the development of a premier operating team, he has led the Company in attracting two strong equity partners, establishing and expanding banking credit facilities, and in the acquisition of 32 independent retail location.

Mr. Misemer founded Tri-Power Fuels in 1988 in order to capitalize on the opportunities he saw in the wholesale propane and natural gas industries. Both industries were being served by companies that lacked a strong service approach. From the very beginning the Company experienced double-digit growth.

Tri-Power has built an excellent relationship with the over 600 retail marketers it currently serves in 35 states. These relationships, along with the relationships developed in banking, the industrial sector, with trading partners and in the business community in general, have all combined to allow Tri-Power to emerge as one of the premier marketers of wholesale propane in the U.S. This year Tri-Power Fuels, now a division of Propane Continental, will market over 200 million gallons (380,000 tons) to marketers in the eastern half of the nation.

Kent is also the Chairman of the Board and principal of York Pharmaceuticals. Kent's business savvy and experience will help to guide York in the future.

Patrick Lais –

Mr. Lais spent 17 years in the animal health industry. He spent 11 of those years managing various veterinary pharmaceutical manufacturing companies. Pat purchased a veterinary manufacturing company on a leverage buy-out in 1987. He successfully turned that company around and grew sales by 300% in 2 ½ years.

He also managed the sales and marketing efforts of the largest animal health distributor in North America for six years. This distributor had 72 locations throughout the United States and Canada and had over 200 sales personnel calling on veterinarians, dealers, swine producers, feedlots, dairies, poultry and cow calf operation. This company's sales grew from $200,000,000 to $360,000,000 while Pat was employed. During this time, he also opened up new markets internationally and successfully launched many new and innovative products. Pat launched an entire product line utilizing beneficial bacteria to re-inoculate the animals. These bacteria containing products can be used in many instances to prevent certain problems from occurring.

In April of 1997, Pat took over as President of York Pharmaceuticals, a manufacturer of over-the-counter health and beauty care products. York manufactures over 50 different products sold under a York label or under numerous private label. This company has already seen double digit growth and has recently acquired a company in San Antonio, Texas and a new operating facility in Kansas City, Kansas.

Travis Herman –

Mr. Herman grew up in rural America spending all of his life in and around Scott City, Kansas. Travis spent his early years working around the feedlot and swine industry. While attending school at Kansas State, Travis worked for Walco International selling pharmaceuticals, biologicals, insecticides and other animal health related products to the feedlot industry in western Kansas. He was very successful in the endeavor making the Chairmans Honor Council his first year.

Mr. Herman left Walco for a ground floor opportunity of helping to build a veterinary division for York Pharmaceuticals. His field experience, education and sales ability will help to make this company successful.

This blend of expertise in research, manufacturing and management, coupled with first hand knowledge of the agriculture industry allows us to target this nationwide problem and to obtain results.

POLLUTION SUMMARY

Animal Waste Pollution Summary

Enclosed is a copy of a report dated December 1997 regarding "Animal Waste Pollution in America: An Emerging National Problem." This report was compiled by the Minority Staff of the United States Senate Committee on Agriculture, Nutrition, and Forestry for Senator Tom Harkin.

Senator Harkin introduced the Animal Agriculture Reform Act, s. 1323 on October 28, 1997. The bill calls for national environmental standards for handling of animal waste.

It is the opinion of Recoverable Resources management that Enviro-Guard can and will assist the producer in obtaining satisfactory results in their handling of animal waste.

ANIMAL WASTE POLLUTION IN AMERICA: AN EMERGING NATIONAL PROBLEM

ENVIRONMENTAL RISKS OF LIVESTOCK & POULTRY PRODUCTION

December 1997

Report Compiled by the Minority Staff of the United States Senate Committee on Agriculture, Nutrition, & Forestry for

SENATOR TOM HARKIN (D-IA)
Ranking Member

1-10

TOM HARKIN
IO

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COMMITTEES:
AGRICULTURE
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SMALL BUSINESS
LABOR AND HUMAN RESOURCES

United States Senate

WASHINGTON, DC 20510-1502

Over the past few years, I have heard increasing concerns in my home state of Iowa about the potential for animal waste pollution from intensive livestock and poultry operations. The concentration of animal waste from larger and larger operations has led to more complaints about odor, greater challenges for animal waste management, and a growing public opinion that more environmental protections are needed.

I was surprised to learn that nationwide 130 times more animal manure is produced than human waste -- five tons for every U.S. citizen -- and that some operations produce as much waste as a town or even a city! As animals become increasingly concentrated in certain regions of the country and on larger operations, there is not always enough crop land to use all of the manure as fertilizer. These increasing concentrations of manure mean that the risk of water pollution from waste spills, runoff from fields and leakage from storage facilities is also increasing.

Furthermore, Federal regulations do not address the handling, storage, land application or disposal of manure. In fact, the Inspector General of the Environmental Protection Agency recently reported that "Federal regulations inadequately protect water quality from animal waste."

The following report explains why I believe that the threat of pollution from intensive livestock and poultry farms is a national problem. Dairy farms in New York and California, poultry farms around the Chesapeake Bay outside of Washington, D.C., and hog farms in North Carolina and Iowa are just some of the places where animal waste has been identified as an environmental problem.

I have introduced the Animal Agriculture Reform Act (S. 1323) in the Senate, the first bill of its kind introduced in Congress, as a national approach to animal waste problems. My bill would set environmental standards for animal waste handling by large livestock and poultry operations, and require those operations to follow waste management plans approved by the U.S. Department of Agriculture.

While most livestock and poultry producers are responsible stewards, the increasing concentration of animal waste is an environmental challenge with national ecological and human health consequences. This is a challenge we must deal with at the national level. National standards also would help prevent larger producers from moving from state to state seeking weaker environmental regulations.

Because of the national importance of this issue, we should move quickly to establish common sense safeguards that will both protect our environment and ensure a sustainable livestock industry. My bill seeks to resolve these problems in ways that are both environmentally responsible and economically feasible for livestock and poultry producers. I look forward to Congressional review of my bill and other proposals early in the upcoming session.

Tom Harkin

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CONTENTS

1-12

EXECUTIVE SUMMARY

The Animal Waste Problem

- Nationwide, **130 times** more animal manure is produced than human waste -- **5 tons** for every person in the United States.

- Applied to land in proper amounts, manure is a valuable source of nitrogen, phosphorus and other crop nutrients -- but more and more animals on larger farms means there is not enough crop land in some areas to use all of the manure.

- The Department of Agriculture reported recently that "The continued intensification of animal production systems without regard to the adequacy of the available land base for manure recycling presents a serious policy problem."

- Inadequate animal waste management practices often lead to water pollution, yet there are no Federal regulations for waste handling, storage, use or disposal.

- Waste spills occur when earthen manure storage lagoons collapse, equipment breaks, or people make mistakes -- and leaking lagoons and runoff from fields can cause chronic animal waste pollution of both surface and ground water.

National Solutions

- The Animal Agriculture Reform Act addresses animal waste pollution problems by requiring large animal feeding operations to develop animal waste management plans that would follow new environmental standards.

- Any national approach to the animal waste problem should include the following policies, found in the Animal Agriculture Reform Act:

    - Environmentally sound standards should be set for the handling, storage, and use or disposal of animal waste.

    - Specific standards similar to those for human waste should require treatment of excess manure that cannot be used for a beneficial purpose.

    - Animal waste management practices must limit the application of both phosphorous and nitrogen in animal manure to amounts needed by crops.

    - The Environmental Protection Agency should maintain its regulatory role, but the Department of Agriculture should be actively engaged in setting new animal waste management standards and helping farmers implement sound environmental practices for livestock and poultry production.

Animal Waste Pollution

- In 60 percent of rivers and streams that EPA has identified as "impaired," agricultural runoff, including nutrients from animal waste, is the largest contributor to pollution.

- **35 million gallons** of spilled animal waste killed **10 million fish** in North Carolina in 1995. Last year more than **40 animal waste spills** killed 670,000 fish in Iowa, Minnesota and Missouri, up from 20 spills in 1992.

- Animal wastes carry parasites, bacteria and viruses -- and can pollute drinking water with high levels of nitrates, potentially fatal to infants.

- Nutrient pollution can come from a number of sources, but in areas of intensive livestock production, animal waste is a leading suspect in blooms of toxic microbes linked to excessive nutrients:

  - In 1997, outbreaks of the toxic microbe *Pfiesteria piscicida* killed approximately **450,000 fish** in North Carolina and approximately 30,000 fish in the Chesapeake Bay (Delaware, Maryland and Virginia).

  - Between 1972 and 1995, the number of coastal and estuarine waters that host major, recurring attacks by harmful microbes has doubled.

  - 22 species of harmful dinoflagellates were known in 1982; now there are over 60.

- Excessive growth and decay of algae in nutrient enriched waters depletes available oxygen. In the Gulf of Mexico, nutrients from farm runoff including animal waste is linked to the formation of a "dead zone" of hypoxia (low oxygen) -- **up to 7,000 square miles of water that cannot support most aquatic life.**

Animal Waste Production

Estimated Annual U.S. Manure Production (1997)
1.37 Billion Tons

Animal	Solid Manure (tons/yr)
Cattle	1,229,190,000
Hogs	116,652,300
Chickens	14,394,000
Turkeys	5,425,000
	1,365,661,300

1-14

- The manure from a 200-head dairy operation produces as much nitrogen as is in the sewage from a community of 5,000-10,000 people.

- The annual litter from a typical broiler house of 22,000 birds contains as much phosphorous as is in the sewage from a community of 6,000 people.

- The 1,600 dairies in the Central Valley of California produce more waste than a city of **21 million people**.

- On the Delmarva Peninsula outside of Washington, D.C., **600 million chickens** a year produce over 3.2 billion pounds of raw waste each year -- as much nitrogen as from **a city of almost 500,000**.

Livestock Production & Concentration

Increasing concerns about the environmental consequences of livestock and poultry production are related to the increasing concentration of animals in certain areas of the country and on larger farms.

Livestock Production in the United States

Broilers	**7.6 Billion (1996)**
Turkeys	**300 Million (1996)**
Hogs	**103 Million (1995)**
Cattle (non-dairy)	**58 Million (1995)**

- Over the past 15 years the number of hog farms has dropped from 600,000 to 157,000, yet these farms still produce about the same number of hogs.

- In the cattle industry, 2 percent of feed operations account for over 40 percent of all cattle sold.

- Between 1969 and 1992, the number of farms with broiler houses fell by 35 percent, but during the same time production nearly tripled.

ANIMAL WASTE & THE ENVIRONMENT

Animal waste from intensive livestock and poultry production presents serious risks of environmental pollution. In 60 percent of rivers and streams that EPA has identified as "impaired," agricultural runoff, including nutrients from animal waste, is the largest contributor to pollution.[1]

Nationwide, **130 times more animal waste is produced than human waste -- 5 tons per person**[2] -- making some large livestock operations the waste equivalent of a town or even a large city. One dramatic example is a 50,000 acre swine operation in southwest Utah designed to produce 2.5 million hogs annually, with a potential waste output greater than entire city of Los Angeles, California.

The lack of sufficient land on which to safely apply the manure from ever larger livestock operations has created what the Department of Agriculture calls "a serious policy problem."[3]

Improper Handling of Animal Waste Leads to Water Pollution

Both liquid and dry animal manure can be a valuable source of crop nutrients. But when manure is applied to land in amounts greater than can be used by crops and retained by the soil, nitrogen, phosphorous and other nutrients leach and run off into surface and groundwater.

Leaching from earthen waste storage lagoons also may pollute ground water. Following a disastrous series of spills in 1995 in North Carolina, researchers examined manure lagoons across the state and found that half of the lagoons constructed prior to 1993 were leaking liquid manure into the soil and groundwater.

The risk of water pollution from dry poultry litter is greatest after it is spread on crop land, while the risk of waste spills and chronic pollution is always present in liquid waste storage and application systems (hogs and cattle). Equipment or structural failures or human error can lead to waste spills while liquid waste is being transported, stored or applied to land. Earthen lagoons, for example, may be vulnerable to outright collapse if overloaded or poorly maintained.

Spills of liquid animal waste directly into water have an immediate environmental impact, choking out fish and other aquatic life. In addition, the excessive growth and decay of algae and other aquatic organisms that feed on excessive nutrients in water deplete dissolved oxygen. The

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[1] **Executive Summary of the National Water Quality Inventory: 1994 Report to Congress**, Office of Water, U.S. Environmental Protection Agency, December 1995, p. 14.

[2] From data provided by the Center for Agricultural & Rural Development at Iowa State University and the Environmental Protection Agency.

[3] **Water Quality: A Report of Progress**, U.S. Department of Agriculture, September 1997, p. 7.

resulting hypoxia (low oxygen) from chronic nutrient enrichment can result in fish kills, odor and overall degradation of water quality.

Serious spills of animal waste into waterways have occurred frequently in recent years. An informal survey of leading livestock-producing states indicates that state enforcement actions taken in response to spills or discharges nearly doubled between 1992 and 1995. In Iowa, Minnesota and Missouri (accounting for 36 percent of hog production), recorded animal waste spills rose from 20 in 1992 (killing at least 55,000 fish) to more than 40 in 1996 (killing at least 670,000 fish).

It has long been known that nitrogen is highly soluble and susceptible to leaching and run off. Only recently has it been fully understood that when soils are saturated with phosphorous, excess phosphorous also will run off. Traditionally, application rates of manure have been set by the amount of nitrogen going onto the land. But because the phosphorus content of manure is proportionally much higher than nitrogen (in relation to crop nutrient needs), this practice can lead to the application of excess phosphorous.

Typical Animal Waste Management Practices

Animal waste consists of not only manure and urine, but also of dead animals, used bedding, waste feed, and other residual organic matter. All of these materials are potential sources of crop nutrients, but also can pose environmental threats.

The composition of animal waste depends on both the kind of animal and the way the waste is handled. Poultry operations typically produce dry litter, with about 15-25 percent moisture content, that may be mixed with straw or another dry material for easier handling. The removed litter is stacked and stored in metal or wooden structures, or on the ground on a temporary basis.

Hogs and cattle generate a manure that is more liquid, and typically water is used to flush the manure out of the barns and into storage facilities. The resulting "slurry" is up to 97 percent liquid, and most commonly stored in earthen lagoons. An alternative storage method now being adopted more widely is the "slurry tank," which offers a greater level of structural stability and environmental protection.

In the lagoons or tanks, many of the solids (including much of the phosphorous) settle into a sludge at the bottom. Most nitrogen remains dissolved in the water or volatilizes into the atmosphere. A farmer who utilizes the animal waste for nutrients pumps the liquid out for nutrients or irrigation, and may agitate the sludge at pumping time to capture the nutrients that otherwise would remain behind.

Where National Standards Are Needed

Figure 1 below illustrates several poultry waste handling methods; **Figure 2** illustrates several methods for handling hog waste. The waste management practices pictured here, however, are not adequate for environmental protection unless the farmer also follows proper standards for building and maintaining the storage facilities, handling manure properly, and spreading manure in limited quantities on the fields. There are no Federal regulations setting these standards.

Waste storage lagoons that may be called "waste treatment lagoons" are typically for waste storage only. Because many of the solids settle into a sludge at the bottom of a waste lagoon, some operations use multiple lagoons for repeated settling and can recapture water that is clean enough to recycle for flushing the barns.

Even these recycling systems, however, do not follow the environmental standards associated with the treatment of human waste. For adequate protection of the environment and human health, treatment similar to that for municipal wastewater should be followed (as discussed below).

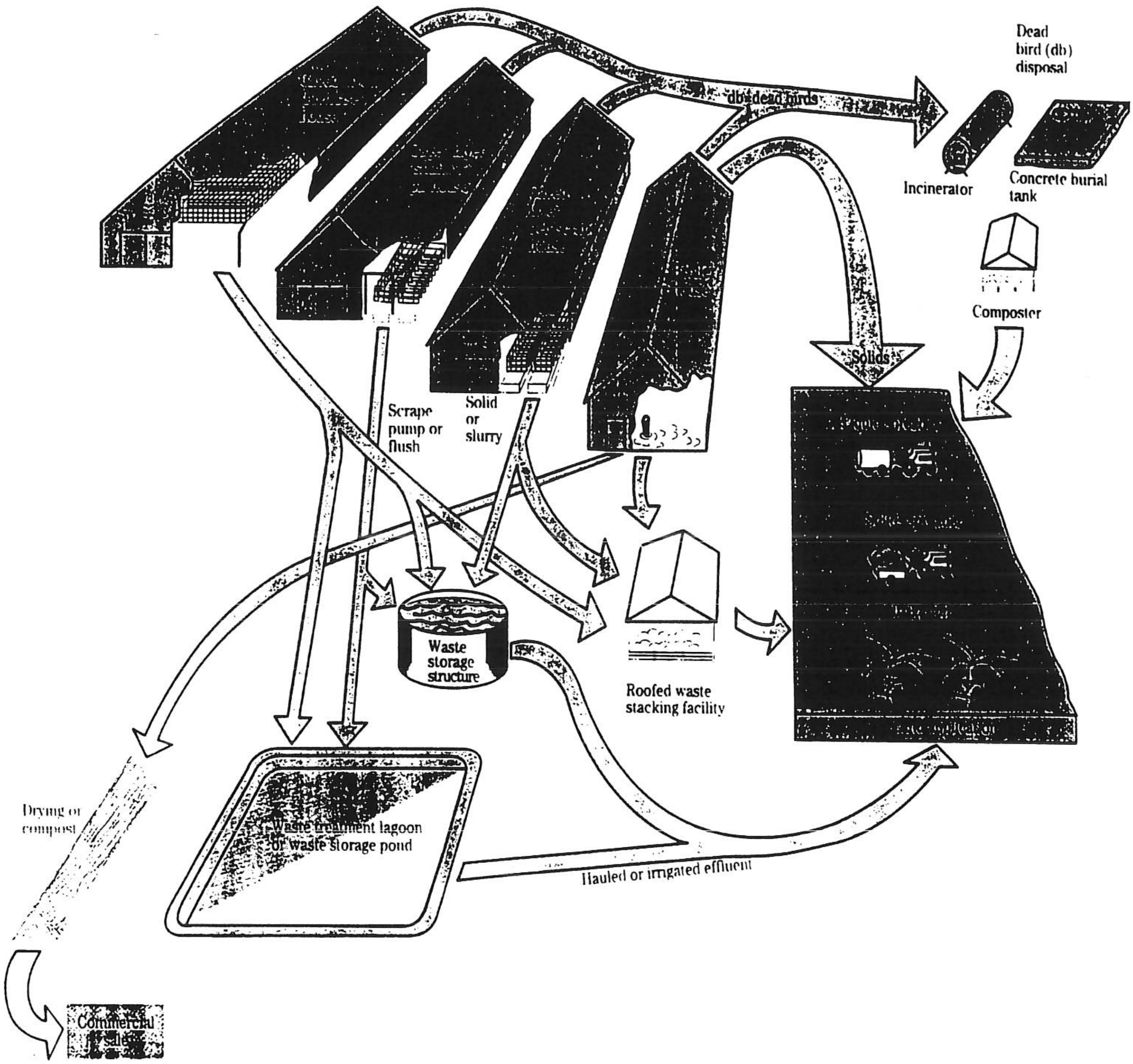
Human Health Concerns

Much current attention is focused on the direct impacts of animal waste on aquatic ecosystems, but there are also human health concerns associated with animal waste pollution that should be studied further. Manure contains pathogens to which humans are vulnerable, including *Salmonella* and *Cryptosporidium*, and can pollute drinking water with nitrates, potentially fatal to infants. More indirectly, microbes that are toxic to animals and people are thought to thrive in waters that have excessively high levels of nutrients from sources including animal waste pollution.

Adopting environmentally responsible animal waste management practices, such as those set forth in the Animal Agriculture Reform Act, would help mitigate a number of these serious potential human health threats. By containing animal waste properly, observing application limits for use of manure as fertilizer, and applying treatment standards to excess manure, the human health impacts of animal waste can be minimized.

FIGURE 1

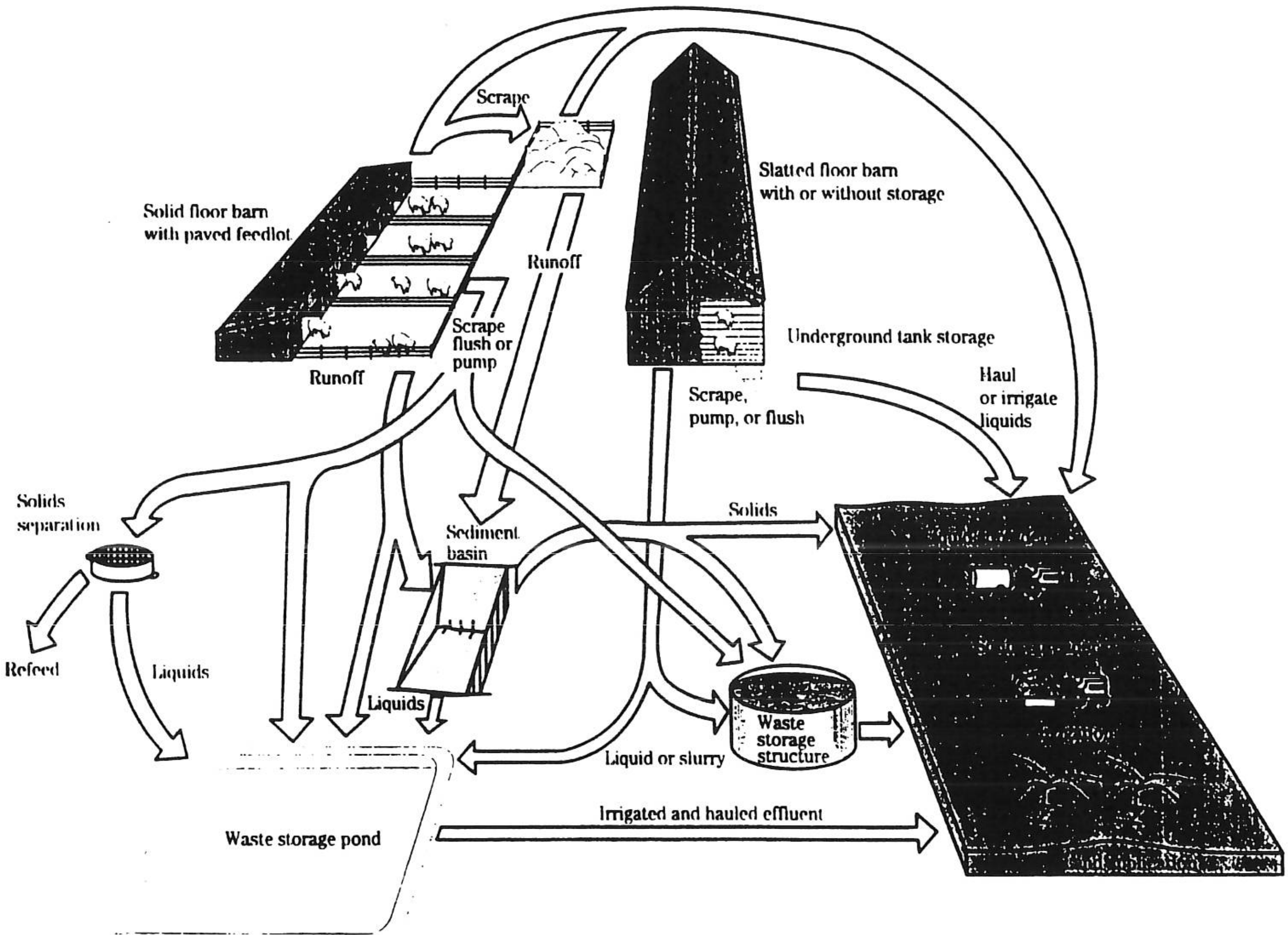
POULTRY WASTE HANDLING METHODS



Source: Agricultural Waste Management Field Handbook, SCS/USDA (1992)

FIGURE 2

HOG WASTE HANDLING METHODS



Source: Agricultural Waste Management Field Handbook, SCS/USDA

Animal Waste Treatment

The Animal Agriculture Reform Act calls for treatment of animal waste, when necessary, much as municipal sewage is treated. When too much liquid manure is produced to be used for crop nutrients or another beneficial use, it should be treated to ensure adequate protection of the environment and human health.

Treatment requirements similar to those that apply to human waste should be considered as part of any comprehensive approach to managing the 1.3 billion tons of animal manure produced annually.

Municipal Wastewater Treatment

- ***Primary treatment*** -- Larger solids are removed from the water by screening, grinding and settling. Settled solids are removed for decomposition, and eventually may need further treatment before disposal.

- ***Secondary treatment*** -- Dissolved organic materials are reduced by biological decomposition.

- ***Tertiary treatment*** -- Additional filtration, if necessary, increases the quality of the water and reduces the need for disinfection.

- ***Disinfection stage*** -- Most of the remaining viruses and bacteria are killed (usually with chlorine).

Some waste storage and application systems on livestock farms are rudimentary waste treatment systems. High volumes of water are used to flush out the manure into below-building pits, and then into waste lagoons. In a lagoon or tank, many of the solids settle into a sludge at the bottom. By using multiple lagoons for repeated settling, a livestock operation can recapture water from the waste stream that is clean enough to recycle for flushing the barns. Typically such "treatment," however, is designed only to recycle water, not to provide environmental safeguards.

Composting

Composting animal waste prior to land application offers significant benefits, although currently it is practical only for dry waste (poultry) operations. The composting of manure, dead animals and other organic materials breaks down organic compounds so they may be more readily used by crops, and the high heat naturally generated by composting kills pathogens. For these reasons, composting may be an adequate treatment for dry waste. Composted dry waste also may be sold commercially for fertilizer.

ANIMAL WASTE POLLUTION -- EXAMPLES

- In 60 percent of rivers and streams identified by EPA as "impaired," agricultural runoff, including animal waste, is the largest contributor to pollution.

- In 1995 in North Carolina:
  - 35 million gallons of animal waste spilled into the state's waterways.
  - Kills of 10 million fish were attributed largely to animal waste pollution.
  - Animal waste pollution closed over 360,000 acres of coastal wetlands to shellfish harvesting.

- In Iowa, Minnesota and Missouri -- accounting for 36 percent of 1996 U.S. swine production -- recorded animal waste spills rose from 20 in 1992 (killing at least 55,000 fish) to more than 40 in 1996 (killing at least 670,000 fish).

- Between 1972 and 1995, the number of coastal and estuarine waters that host major, recurring attacks by harmful microbes has doubled -- and nutrient enrichment from sources including animal waste is the leading suspect.

  - In 1997, approximately 450,000 fish were killed in North Carolina by the toxic microbe *Pfiesteria piscicida*, whose increased presence in estuarine waters is linked to excess nutrients from animal waste and farm runoff.

  - In 1997, an estimated 30,000 fish were killed in the Chesapeake Bay by *Pfiesteria*, implicating nutrient runoff from the poultry farms on the Delmarva Peninsula that produce over 600 million birds per year.

  - Symptoms reported among people with close exposure to *Pfiesteria* in its toxic form include memory loss, respiratory problems and skin rashes.

  - 22 species of harmful dinoflagellates were known in 1982; now there are over 60.

  - Public concerns about nutrient enrichment of waterways also have been heightened by other attacks by toxic algae and microbes in recent years:
    - 3 people dead and 100 sick in Canada
    - 162 dolphins, a sea lion and at least 4 whales dead in Mexico
    - Thousands of tropical fish dead off Florida
    - 304 dead manatees in Florida
    - Hundreds of brown pelicans dead in California

- Gulf of Mexico: Nutrients from farm runoff, including animal waste, are linked to the formation of a so-called "dead zone" of hypoxia (low oxygen) in the Gulf as large as 7,000 square miles.

ANIMAL WASTE PRODUCTION -- FACT SHEET & MAPS

- The following maps detail concentrations of manure across the country, measured by both nitrogen and phosphorous from manure. This concentration makes it significantly more difficult to effectively manage animal waste and utilize manure for such beneficial uses as fertilizer.

- Maps soon to be released by USDA indicate that in a number of these areas of high concentration there is simply not enough crop land to utilize the manure.

Estimated Annual U.S. Manure Production (1997)[4]
1.37 Billion Tons

Animal	Solid Manure (tons/yr)
Cattle	1,229,190,000
Hogs	116,652,300
Chickens	14,394,000
Turkeys	5,425,000
	1,365,661,300

- More than **five tons** of animal manure are produced each year for every person in the United States, compared to about 80 pounds of solid human waste.

- The annual production of over 600 million chickens on the Delmarva Peninsula (the Chesapeake Bay tri-state area) yields:
  - Over 3.2 billion pounds of raw waste each year.
  - 13.8 million pounds of phosphorous.
  - 48.2 million pounds of nitrogen -- **as much nitrogen as in the waste from a city of 490,000**.

- The 1,600 dairies in the Central Valley of California produce ***more waste than a city of 21 million people***.

- A 50,000 acre swine operation under construction in Utah is designed to produce up to **2.5 million** hogs per year -- with a potential waste output ***greater than that of the city of Los Angeles***.

- The manure from a 200-head dairy operation produces as much nitrogen as is in the sewage from a community of 5,000-10,000 people.

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[4] Center for Agricultural and Rural Development, Iowa State University.

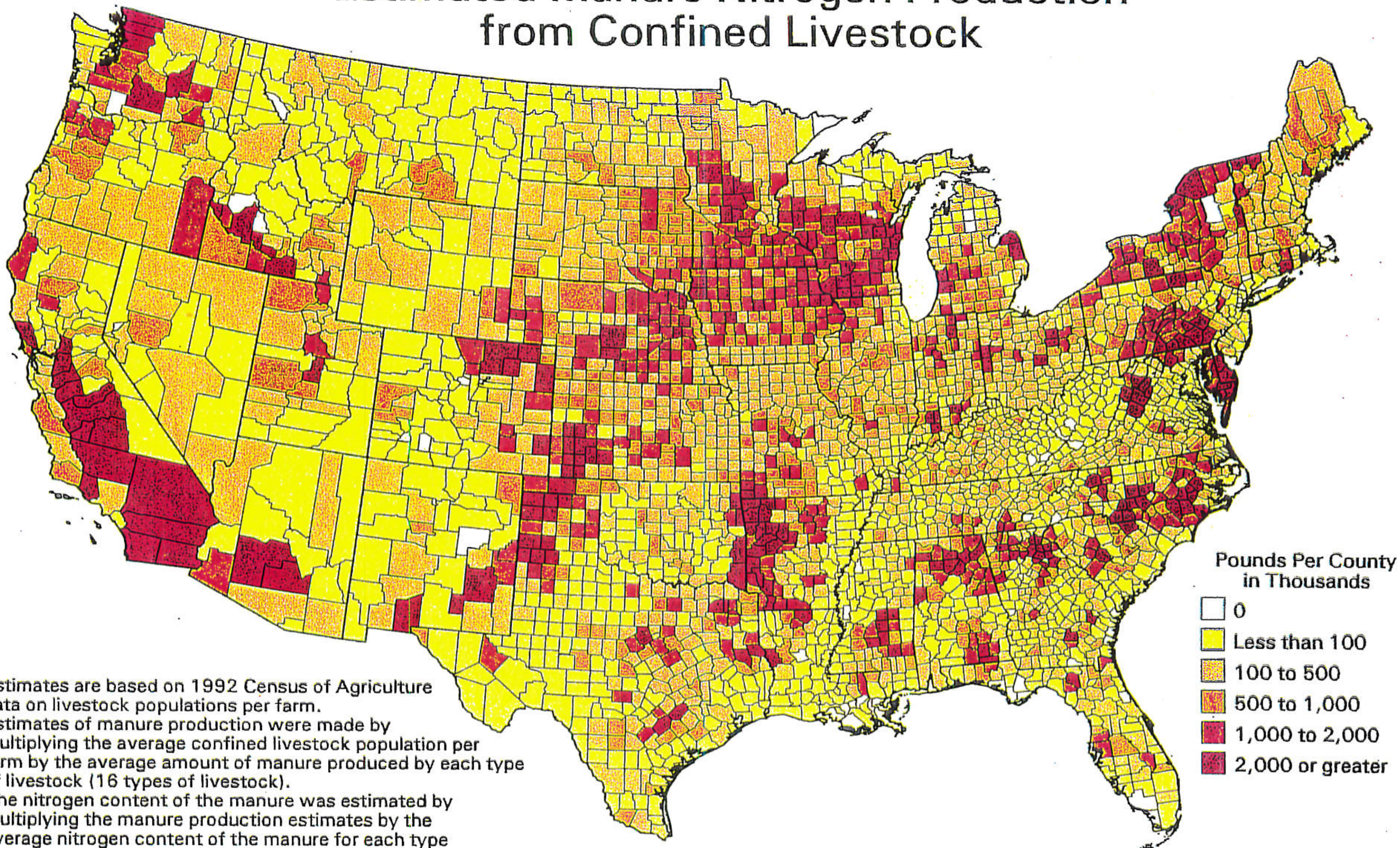
- The annual litter from a typical broiler house of 22,000 birds contains as much phosphorous as is in the sewage from a community of 6,000 people.

Livestock Manure and Nutrient Production[5]

	Solid Manure (tons/yr/animal)	Nitrogen (lbs/yr/animal)	Phosphate (lbs/yr/animal)
Hogs			
Finishing Hogs	1.9	29	18
Breeding Sows	3.1	39	25
Cattle			
Milk Cows	20	239	120
Beef Cows	12	147	73
	(tons/1000-head-yr)	(lbs/1000-head-yr)	(lbs/1000-head-yr)
Chickens			
Layers	10	816	672
Broilers	9	585	585
Turkeys	35	1400	1400

[5] Center for Agricultural and Rural Development, Iowa State University.

Estimated Manure Nitrogen Production from Confined Livestock

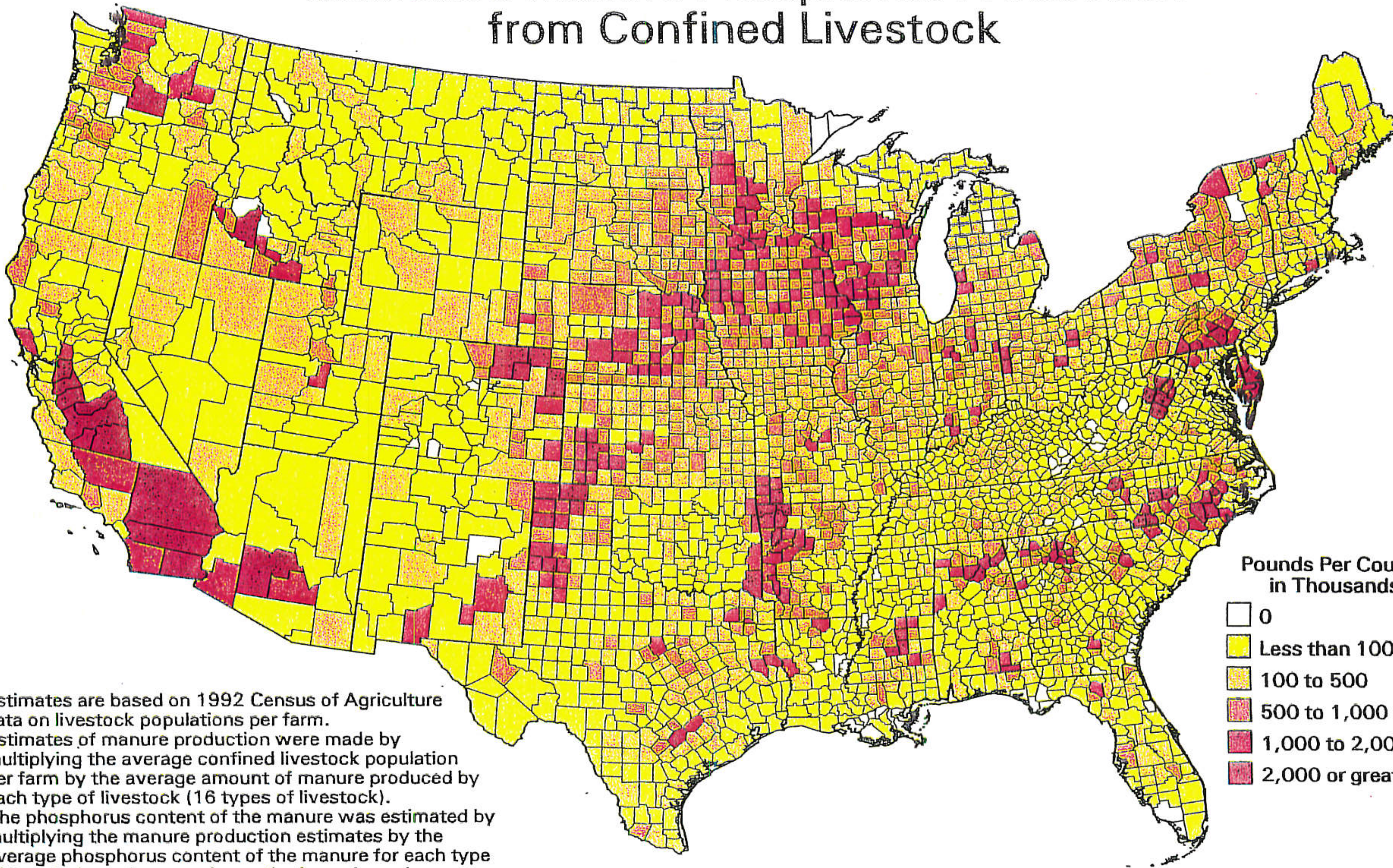


- Estimates are based on 1992 Census of Agriculture data on livestock populations per farm.
- Estimates of manure production were made by multiplying the average confined livestock population per farm by the average amount of manure produced by each type of livestock (16 types of livestock).
- The nitrogen content of the manure was estimated by multiplying the manure production estimates by the average nitrogen content of the manure for each type of livestock, and summed over the farms in each county.
- Estimates were adjusted for typical losses of nitrogen during storage and application.
- Estimates were not adjusted for plant uptake and removal.
- Estimates were not made for Alaska, Hawaii, or other U.S. commonwealths, territories, or the freely associated governments of the Pacific Basin.

U.S. Department of Agriculture
Natural Resources Conservation Service
Resource Assessment and Strategic Planning Division
Map ID: 2390, October 1997

1-25

Estimated Manure Phosphorus Production from Confined Livestock



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U.S. Department of Agriculture
Natural Resources Conservation Service
Resource Assessment and Strategic Planning Division
Map ID: 2391, October 1997

1-26

LIVESTOCK CONCENTRATION -- FACT SHEET, CHARTS & MAP

Increasing concerns about the environmental consequences of livestock and poultry production are related to the increasing concentration of animals in certain areas of the country and on larger farms. The resulting concentrations of manure make it much more difficult to manage waste responsibly and utilize all the manure for fertilizer.

This concentration of animals without sufficient crop land in those areas for manure application is an increasing problem. In 1992, for example, the largest hog operations (more than 2,500 hogs per farm) held more than 27 percent of the nation's hogs but owned only 3 percent of crop land associated with animal operations.

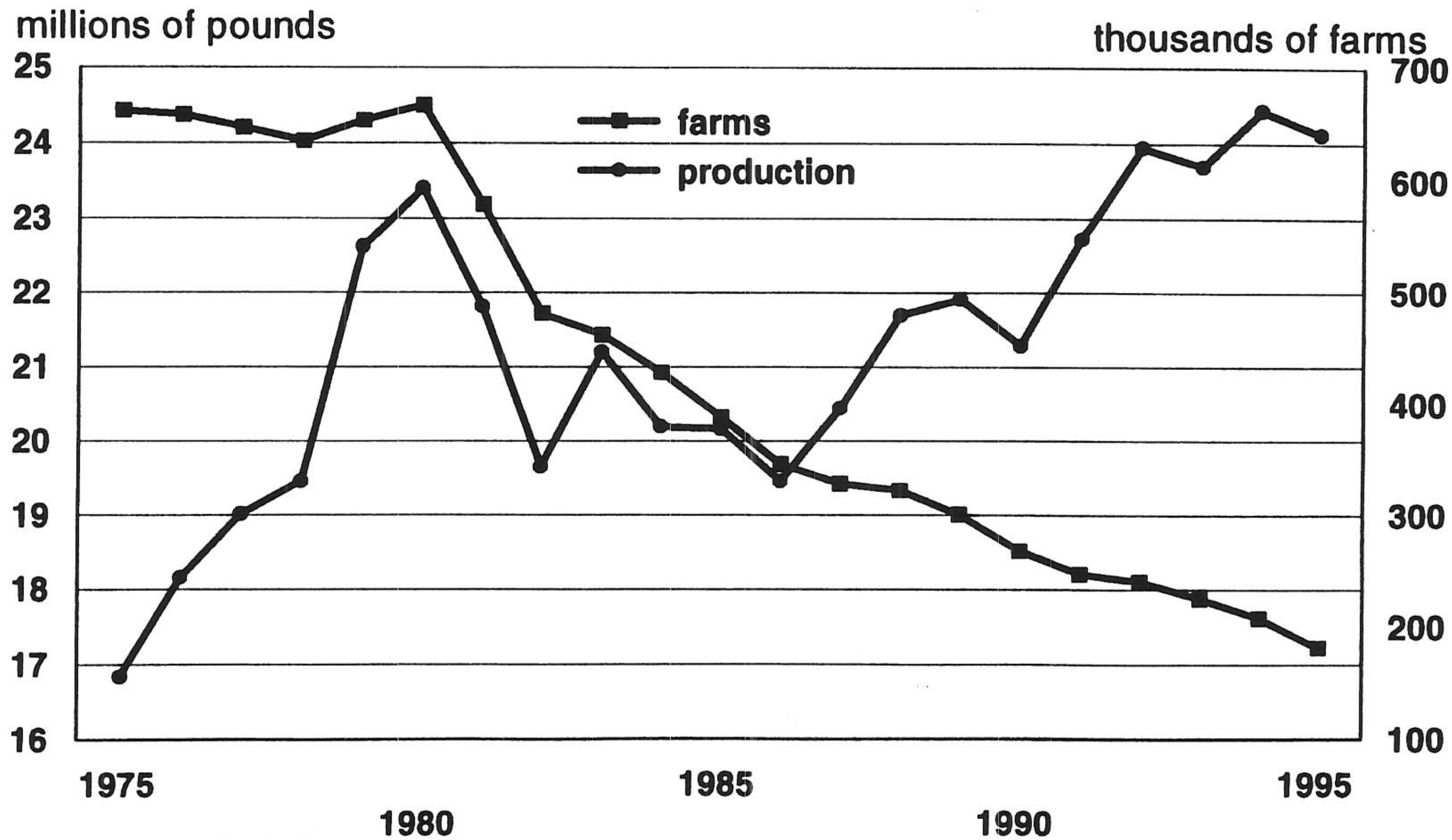
The following charts show that while the number of farms raising various types of livestock and poultry have declined, the number of animals produced has risen at the same time. The map following the charts shows the regions where these animals are now concentrated.

Livestock Production in the United States

Broilers	**7.6 Billion (1996)**
Turkeys	**300 Million (1996)**
Hogs	**103 Million (1995)**
Cattle (non-dairy)	**58 Million (1995)**

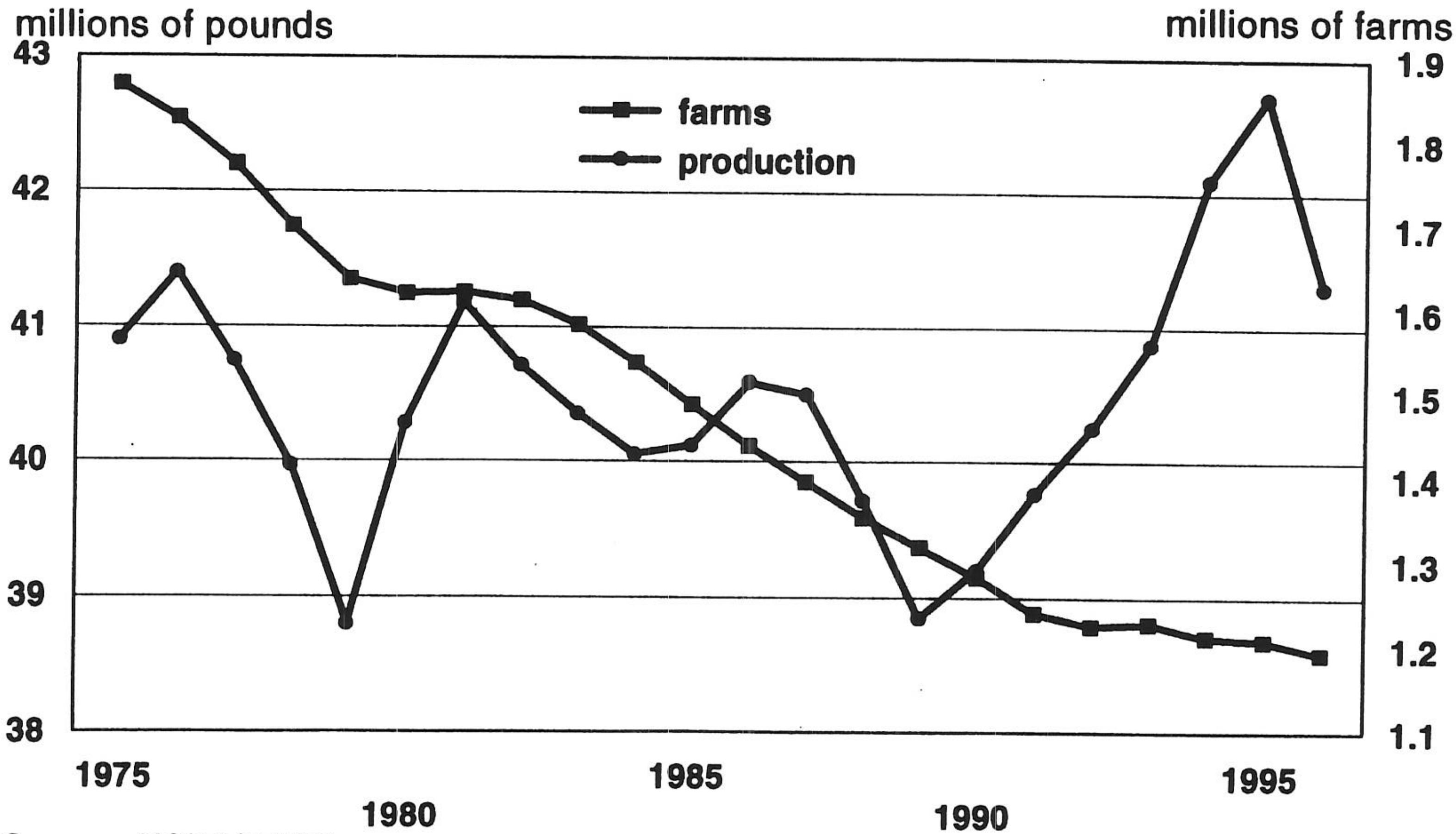
- Thirty years ago there were more than a million hog farms across the country. Over the past 15 years the number of hog farms has dropped from 600,000 to 157,000, yet the country's hog inventory has remained almost the same.
- As a result of increased concentration, just 3 percent of the nation's hog farms produce more than 50 percent of the nation's hogs.
- 2 percent of cattle feed operations account for over 40 percent of all cattle sold.
- Between 1969 and 1992, the number of farms with broiler houses fell by 35 percent, but during the same time production nearly tripled.
- In 1996, 55 percent of hog production took place in four states. In the same year, the four-state concentration for poultry production was 53 percent.
- Out of 640,000 U.S. livestock farms, 450,000 are confined feedlot operations.
- About 6,600 of those animal feeding operations account for about 35% of total US livestock production.

U.S. pork production and number of operations, 1975-95



Source: USDA/NASS

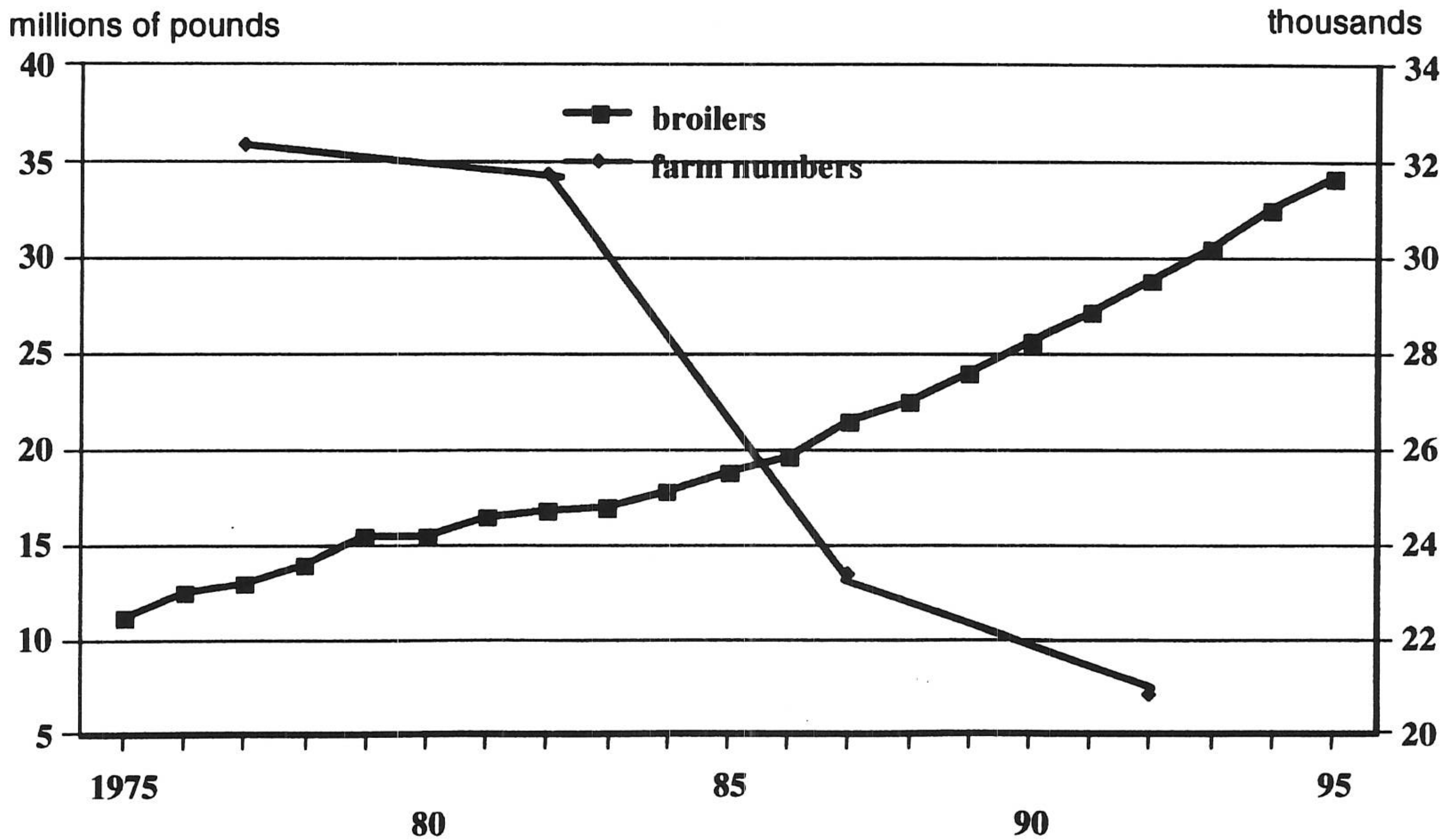
U.S. beef production and number of operations, 1975-96



Source: USDA/NASS

1-29

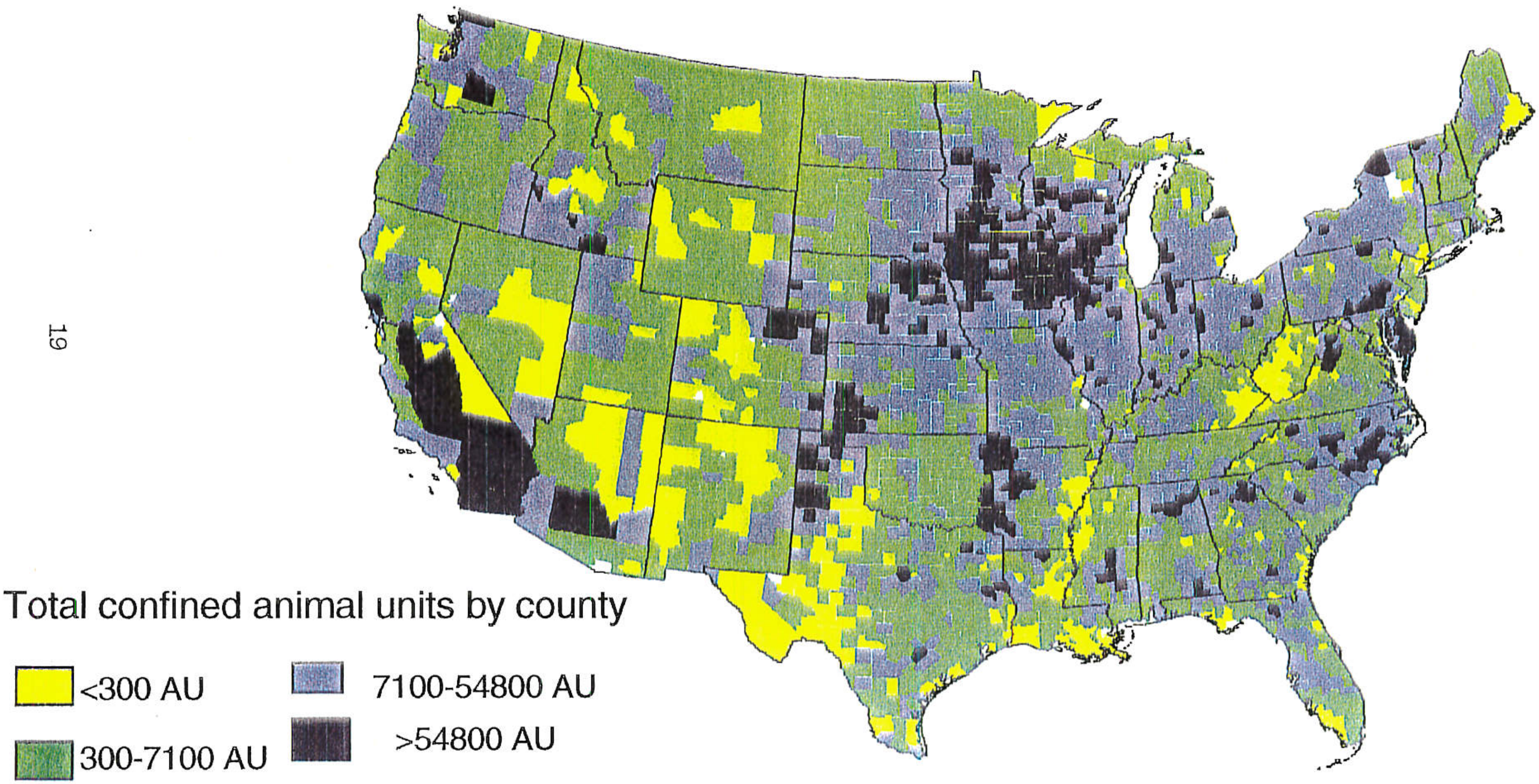
Broiler numbers and numbers of farms, 1975-95



Source: USDA/NASS, and Census of Agriculture, various years

1-30

Concentration of livestock and poultry operations, 1992



Note: 1000 Animal units (AU)=1,000 beef cattle; 700 dairy cattle; 2500 hogs; or 455,000 broilers.
Source: ERS/USDA.

CURRENT NATIONAL ACTIONS

Clinton Administration Clean Water Action Plan

- In October, Vice President Gore directed the Environmental Protection Agency and the Department of Agriculture to work with other Federal agencies to develop a Clean Water Action Plan by February 14, 1998. The Plan will describe specific actions that Federal agencies will take to: 1) protect public health; 2) prevent polluted runoff; and 3) promote community-based watershed management.

- **The Vice President listed animal feeding operations as a key source of water pollution to be addressed by the Action Plan.**

Environmental Protection Agency

EPA is considering actions to address animal waste pollution, including:

- New Clean Water Act regulations;
- Increased inspections of operations; and
- Stepped up enforcement against polluting operations.

Department of Agriculture

- USDA is working with EPA on the Administration's Clean Water Action Plan. The Natural Resources Conservation Service is reviewing and revising guidelines on animal waste management.

National Environmental Dialogue on Pork Production

- The National Environmental Dialogue on Pork Production (NEDPP) is a working group composed of the Department of Agriculture, the Environmental Protection Agency, several state environmental and agriculture departments, and individual pork producers affiliated with the National Pork Producers Council.

- This month, the NEDPP recommended that environmental regulations for swine operations:

    - Apply to all sizes of commercial operations.
    - Require new operations to comply with recognized engineering standards.
    - Limit manure application by crop nutrient needs and soil nutrient levels.
    - Require certification and training for facility operators.
    - Require setbacks from water bodies, residences and other public facilities.
    - Allow public notice and comment on proposed operations.

THE ANIMAL AGRICULTURE REFORM ACT, S. 1323

Senator Tom Harkin (D-IA) introduced the Animal Agriculture Reform Act in the United States Senate on October 28, 1997. The bill calls for national environmental standards for the handling of animal waste by large animal feeding operations. These standards would be implemented through mandatory animal waste management plans approved by the Department of Agriculture.

The bill does not interfere with the regulatory role of the Environmental Protection Agency or state governments. Instead, it provides a directive for USDA to implement waste management standards on individual farms. USDA is not required to monitor for pollution.

Under the Animal Agriculture Reform Act:

- Livestock and poultry operations would submit detailed plans to USDA for:
  - Minimizing animal waste runoff and leaching into water.
  - Operating, monitoring, maintaining and inspecting waste storage facilities.
  - Handling, transporting, storing, applying and treating animal waste.
  - Building containment systems according to national technical standards.
  - Containing accidental waste spills.
- Manure may not be applied in amounts that exceed crop nutrient requirements and increase the risk of water pollution.
- Liquid manure that cannot be applied in accordance with nutrient restrictions or put to another beneficial use must be treated in accordance with waste water treatment standards.
- Funding for USDA's Environmental Quality Incentives Program would be quadrupled from $200 million per year to $800 million per year, and assistance for smaller operations to prepare animal waste management plans would be a priority.
- Animal owners are responsible for preparing and complying with the animal waste management plan, even if they contract with others to raise the animals.
- If EPA or a state finds that an operation is a significant polluter, USDA must review the operation's compliance with its management plan. USDA may close an operation that does not comply with its plan or fails to file an approved plan.
- State and local governments may apply tougher standards than those in the bill.
- Waste management plans are mandatory for operations over an approximate capacity of 1,330 hogs; 57,000 chickens; 270 dairy cattle; or 640 feeder cattle.

Current Regulations & Programs

The Environmental Protection Agency

Several Federal statutes under the Environmental Protection Agency's jurisdiction cover aspects of animal feeding operations. The Clean Water Act is the most significant, but regulations under this statute are limited, and do not cover such key issues as land application of manure, nutrient management, animal waste management plans and engineering standards.

The Clean Water Act of 1972 (CWA)

The CWA is the most significant federal statute covering livestock operations. Under the CWA, no point source may discharge pollutants unless it is in accordance with a permit issued by EPA or a state under EPA's National Pollutant Discharge Elimination System (NPDES).

- **The CWA defines a "point source" as:** "any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, **concentrated animal feeding operation (CAFO)**, or vessel or other floating craft, from which pollutants are or may be discharged."

- The CWA does not specifically define a CAFO. EPA's regulations, written in 1976, define a CAFO as an animal feeding facility in which animals are confined for 45 days or more out of a 12-month period, over which no crops or forage growth is sustained, and that either:

  - Contains 1,000 animal units and has the potential to discharge pollutants into water by any means;

  - Contains over 300 animal units and is discharging pollutants through a man-made device (*e.g.*, pipes or ditches) directly into a water body; or

  - Is designated a CAFO after a site inspection determines that the operation is or has the potential to be a significant polluter, no matter its size.

- 1,000 pound "animal units" equal 1,000 beef cattle; 700 dairy cattle; 2,500 hogs; 10,000 sheep; 455,000 broilers; or 66,700 turkeys. (EPA's CAFO regulations set different thresholds for poultry, using 55,000 turkeys and from 30,000 to 100,000 chickens depending on the type of operation.)

An NPDES permit prohibits discharges to water except those resulting from a storm exceeding a 25-year, 24 hour storm (*i.e.*, the number of inches of rainfall in a 24-hour period that it is expected only once every 25 years). An animal feeding operation that ***only*** discharges in the event of a 25-year, 24-hour storm is not considered a CAFO.

Coastal Zone Act Reauthorization Amendments of 1990

- CZARA calls upon states with federally-approved coastal zone management programs (voluntary programs under the original Coastal Zone Management Act of 1972) to implement coastal nonpoint pollution control programs. EPA's technical guidance for such nonpoint control programs includes management measures for "confined animal facilities."

- Although CZARA management measures apply to farms smaller than those specified under the CWA CAFO regulations, any CAFO with an NPDES permit is exempt from CZARA requirements.

Safe Drinking Water Act

- Under the SDWA, animal feeding operations that are identified as a source of groundwater contamination, are within a designated wellhead protection area, or that are located near public water systems may be subject to additional discharge limitations or management practices.

The United States Department of Agriculture

USDA does not have regulations that govern animal waste management. However, the Natural Resources Conservation Service provides conservation assistance to farmers that includes waste and nutrient management for livestock and poultry farms.

- Under the new **Environmental Quality Incentives Program (EQIP)**, established by the 1996 Farm Bill:

  - USDA enters into 5- to 10-year contracts with farmers to provide financial, technical and educational assistance for conservation measures. Farmers must implement a conservation plan.

  - Farmers may receive cost-share payments and incentive payments for conservation measures including manure management facilities and nutrient management plans.

  - Fifty percent of EQIP funding is targeted to livestock production. Owners of large confined livestock operations (over 1,000 animal units--see discussion under the Clean Water Act above) are not eligible for cost-share assistance for animal waste storage or treatment facilities. Technical, educational, and financial assistance may be provided for other conservation practices on these large operations.

The States

A survey of 29 states indicates that laws regulating animal waste and manure management vary widely. State and local laws that affect the management of animal feeding operations generally regulate one or more of the following aspects: (1) size or structure of operations; (2) location of facilities; and (3) practices of the operation. A number of states have used the NPDES program as a starting point, and have added additional requirements to those found in EPA's NPDES regulations.

Many states and localities have enacted new laws and regulations very recently, and this is an area of intense activity. North Carolina and Kentucky, for example, recently imposed moratoria on the construction of most new livestock operations.

Among aspects of livestock operations regulated by various states are:

- Separation distances between livestock operations and water wells, private homes, or property lines;
- Amounts of land available for manure application;
- Manure application methods and amounts;
- Capacity of manure storage structures;
- Allowable seepage from waste lagoons;
- Construction standards; and
- Disposal of dead animals.

In some states, disputes have arisen as to whether local jurisdictions have the authority to regulate livestock and poultry operations. Among the sources of legal authority advanced to justify local control are zoning and health ordinances. Typically, proponents of local control are seeking more stringent regulation than is provided by state law.

CONCLUSIONS

Animal waste pollution is a national problem, and current Federal regulations are an inadequate solution. There are no regulations at the national level that set specific requirements for the storage or application of manure, nutrient management, animal waste management plans or construction standards.

Although many states are grappling with this issue on their own, new minimum environmental standards for animal waste management should be established at the Federal level to ensure nationwide protection of the environment and human health.

While the Environmental Protection Agency should maintain its regulatory role, the Department of Agriculture should be actively engaged in setting new animal waste management standards. USDA is the only Federal department with a national staff in place to help farmers implement sound environmental practices for livestock and poultry production.

As part of any new Federal approach to this issue, all large livestock and poultry operations should be required to adopt animal waste management plans that:

- Limit the application of both phosphorous and nitrogen to the amounts that can be used by crops.
- Detail safe methods for handling, storing and applying or disposing of manure.
- Specify how excess manure that cannot be used for crop nutrients or another beneficial purpose will be treated to minimize environmental threats.

Animal waste is not the only threat to water quality. But action must be taken now to minimize the risks to our nation's ground and surface water from livestock and poultry production. Comprehensive national standards for animal waste management, such as those set forth in the Animal Agriculture Reform Act, are an important step toward improving water quality across America.

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MICROBIAL TREATMENT

RECOVERABLE RESOURCES
WASTE MANAGEMENT TREATMENT SYSTEM
Swine Lagoon Treatment

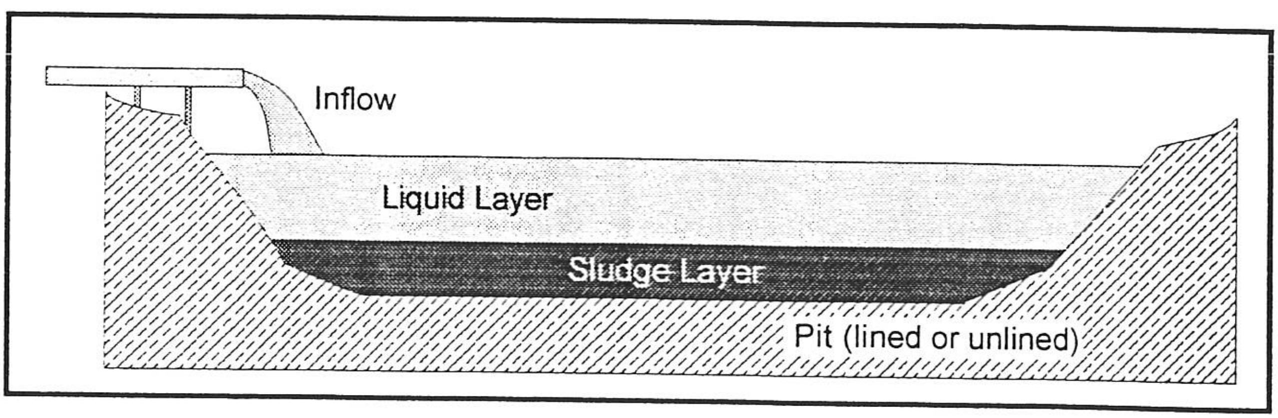
ANIMAL WASTE TREATMENT LAGOONS: Lagoons are used in the treatment of animal wastes on a fairly regular basis. The use of lagoons, however, has had many problems associated with it. Primarily odor problems, but also severe pollution problems if the lagoons overflow into nearby creeks or streams.

The use of **Enviro-Guard** in the removal of odors and in the reduction of sludges in lagoons has proven very effective. **Enviro-Guard** is a blend of selected microbes chosen for their ability to degrade sludges and remove odors. All the microbes are naturally occurring microbes--no genetically-engineered microbes are included in the solution. The solution is safe to use and is non-toxic.

INITIAL TREATMENT: The initial treatment of the lagoon should place enough **Enviro-Guard** into the lagoon to cause a shock-loading effect. To accomplish this **Enviro-Guard** Lagoon Treatment solution is added to the lagoon either by spraying it over the surface or by mixing it in around the edges or adding it into the inflow. The initial loading requirements are determined by size, age, and loading factors of the lagoon.

MAINTENTANCE TREATMENT: To maintain the lagoon **Enviro-Guard** solution should be applied on a regular maintenance schedule. This schedule should be worked out to provide approximately 1 gallon of **Enviro-Guard** solution for every 500 hogs (or animal equivalent) per day. The best way to apply this solution is to feed it into the lagoon inflow. Periodically, the hog barn or animal barn should be washed down using the **Enviro-Guard** solution to keep odors out of the barn areas and to clean the piping flowing to the lagoon.

TREATMENT AMOUNT: One 5-gallon container of **Enviro-Guard** Lagoon Treatment solution will treat approximately 1,000,000 gallons (3 acre-feet) of animal waste in a lagoon.



TYPICAL ANIMAL WASTE LAGOON

ENGINEERING OF THE TREATMENT SYSTEM: **Recoverable Resources** specializes in the treatment of animal wastes. It accomplishes this by reviewing each waste site individually and developing a site-specific waste treatment system for that site. This site-specific system includes consideration of treatment amounts, schedules, and methods, with the methods including any necessary installed equipment.

Every animal waste treatment lagoon has individual aspects that make a standardized treatment difficult. By reviewing each waste site, **Recoverable Resources** can take into account the individual aspects and design an economical, and workable system for each site. One of **Recoverable Resources'** technicians will visit the operation and review the system prior to development of a treatment plan. Various system attributes will be measured during this initial visit such as physical attributes (length, width, depth, etc.), basic water quality, sludge quality and quanitity, and air quality around the lagoon and in the barns. Specific items will also be measured during this visit such as nitrate levels, phosphate levels, BODs, and suspended solids. With this information a site-specific plan for the management of the site will be developed, and **Recoverable Resources** will then work with the operators of the site to educate them on the plan implementation.

PLAN IMPLEMENTATION: Initial shock-loading of the waste lagoon will be accomplished by the on-site technician, while the maintenance treatment will be accomplished by the system operators after the proper treatment system has been installed at the site, the treatment schedule has been developed, and the system operators have been schooled in how to operate the treatment system. The maintenance treatment system can be installed to work in any of the common systems that are now in use at animal waste lagoons such as tip and pour, mini pit/ trip and trigger, or basic pit systems.

PERIODIC MONITORING OF THE SYSTEM: Periodically, **Recoverable Resources** will have a technician monitor the system to check on plan implementation and to make any adjustments in the treatment plan if such adjustments are necessary based on the measurements made at the site of the various system parameters. This may include compliance testing for air and water quality.

ESTABLISHING A NEW ACCEPTABLE BALANCE THROUGH BIOAUGMENTATION OF A PRESENTLY EXISTING EUTROPHIC SYSTEM, LAKE ELSINORE, CALIFORNIA

Introduction – Discussion of a Eutrophic System

Nature operates by setting up steady-state systems in the various environments which exist in nature. In a lake environment a number of steady-state systems can be established. Figure 1 shows an interaction that exists between algae and bacteria. The interaction shown in Figure 1 can form a steady-state in a number of ways. Some of these naturally occurring steady-state systems are considered desirable and some are considered undesirable. As an example, the eutrophic environment found in Lake Elsinore is a naturally occurring steady-state condition, but in most instances, such a system is considered undesirable by most people, and especially is so considered by those who must live near such a eutrophic lake.

In a eutrophic system, algae growth dominates the upper lake waters, while bacterial growth dominates the lower lake waters. The natural steady-state system is established in a vertical layering of the lake waters during the eutrophication process. This results because of the energy production mechanisms utilized by the algae and the bacteria, respectively. As Figure 1 shows, the algae side of the system uses photosynthesis, while the bacterial side of the system uses respiration. Photosynthesis, of course, operates only where solar energy input is available, and in a lake environment that is the top few feet. Respiration, on the other hand, needs organic matter to operate but is not affected by the solar energy coming into the system. When the amount of photosynthesis occurring in a system is equal to the amount of respiration occurring in a system, then the organic matter produced through the photosynthesis is decomposed by the respiration process at the same rate (Stumm and Morgan, 1970). In a eutrophic system such as Lake Elsinore, photosynthesis dominates in the upper levels of the lake and an excess level of organic matter, in the form of algae biomass, is produced. As the algae dies and sinks, it becomes an available organic food supply for the bacteria in the deeper lake waters. Thus, the steady-state system develops in a vertical fashion. Figure 2 shows this steady-state eutrophic system.

The first respiration mechanism which comes into play to utilize the abundant organic material is aerobic respiration, or in other works, respiration using oxygen dissolved in the lade water. The dissolved oxygen present in the water is supplied to the water primarily from two sources. First, oxygen dissolves into the water at the surface from direct contact with the air, and second, oxygen is produced as a by-product of the photosynthesis reaction and is released by the algae into the water. As the aerobic respiration processes occur in the lake waters, they use the dissolved oxygen up. Since the dissolved oxygen is coming into the system at, or near, the surface, the amount available in the water decreases with depth. At the point that the dissolved oxygen is used up and goes to zero. The respiration process changes to an anaerobic reaction system. It is the anaerobic respiration reactions occurring in the oxygen deficient deeper waters that cause the release of odor-causing gases such as hydrogen sulfide. Black & Veatch's 1993 Study of Lake Elsinore has, in fact, found these oxygen variations conditions to be present in the Lake Elsinore waters.

As the algae grow in the surface waters they utilize the carbon dioxide in the water and atmosphere to drive the photosynthesis process. The carbon dioxide is replenished both from the air at the surface of the lake and from the carbon dioxide released in the deeper lake waters as a by-limiting nutrient. As noted, the surface waters will contain high levels of dissolved oxygen, and while this would normally encourage large amounts of bacterial growth, such growth does not occur in a eutrophic system. This lack of massive bacterial growth in the eutrophic lake's surface level waters is the result of several factors. First, algae blooms drive the pH of the water up into the 7 to 10 pH range. This is above the 6.5 to 8.5 range that most bacteria prefer, and therefore, the environment created in the upper level waters is quite hostile to bacteria. Black & Veatch found the pH levels between 8 and 10 in Lake Elsinore. Second, most of the organic matter in the upper levels of the lake's water is tied up in the living algae cells, and is, therefore, not readily available to the bacteria. Any organic matter that is available in the upper level waters is used up in the highly oxygenated waters, and therefore, the system is often carbon limited for the bacteria. Since the algae are utilizing photosynthesis and carbon dioxide they are not limited in this environment and can continue to grow unchecked.

As the eutrophic system develops and establishes a steady-state system, the nutrients which will become growth limiting to the algae are nitrogen and phosphorus. That is why phosphorus-bases soaps or nitrogen and phosphorus rich agricultural runoff can cause such significant eutrophic conditions to occur in rivers and lakes. The Black & Veatch Study of 1993 found that the waters of Lake Elsinore contained naturally high levels of these nutrients, thus, making Lake Elsinore a prime candidate for eutrophic conditions.

To summarize, Lake Elsinore typifies a eutrophic environment with massive algae growth in the upper level waters. The upper level waters also contain high dissolved oxygen, low dissolved carbon dioxide, and high pH values. The dissolved oxygen levels quickly deplete with depth, while the bacterial levels increase, as does the amount of available organic nutrients in the form of decaying biomass. The respiration reactions become anaerobic in the deeper waters as the dissolved oxygen disappears and this results in the release of odor-causing gases. The rate-limiting nutrients in the system are either nitrogen or phosphorus for the algae and available carbon for the bacteria.

Chemistry of the Aquatic Environment

The following considerations must be taken into account when determining a suitable solution for initiating a steady-state system that establishes an equilibrium between algae and bacteria.

Unfortunately, in systems such as Lake Elsinore where historically nutrients have been readily available, algae have the advantage over endogenous bacteria. This is apparent by examining a simplified stoichiometric equation and the following consideration of algal biomass:

$$106\ CO_2 + 16\ NO_3^- + HPO_4^{2-} + 122\ H_2O + 18\ H^+ \text{ (+ trace elements)}$$

$$\textit{photosynthesis} \downarrow\uparrow \textit{respiration}$$

$$\underbrace{106\ H_{263}O_{110}N_{16}P}_{\textit{algal biomass}} + 138\ O_2$$

If 1 mg of phosphorus is available to a photosynthesizing cell, a stoichiometric calculation computes 100 mg of algal biomass.

$$1\ \text{mg P} \times \frac{1\ \text{mmol}}{31\ \text{mg P}} \times \frac{3550\ \text{mg biomass}}{1\ \text{mmol}} = 100\ \text{mg biomass}$$

As this 100 mg of algal biomass settles to the bottom of the lake, 140 mg of biochemical oxygen demand is required for its mineralization.

As noted above, by limiting essential nutrients growth rates of algae can be controlled. However, the rates of assimilation of nutrients by algae and bacteria are nearly the same as was found in Fogg and Thake, 1987, and Grady and Lim, 1980. These data, or course, vary from species to species, but are representative of actual growth rates. The competition for nutrients plays an important role, and those that survive are the ones that are quickest in reaching the available nutrients and taking them up (Rheimheimer, 1974).

Many times bacteria are limited in growth rates by available organic carbon. Bacteria depend on processes from photosynthetic plants directly and indirectly as seen by the carbon cycle drawn as Figure 3. Bacteria directly use extracellular products from algae as sources of organic carbon (Colwell and Speidel, 1985). Algae are not limited by carbon because much of the carbon is attained from the atmosphere in the form of gaseous CO_2, as can also be seen from the photosynthesis equation above. However, as the algae die off from the lack of available nutrients, ample organic carbon will be available to facilitate vigorous bacterial activity.

Reactions involving nitrogen and the nitrogen cycle are clearly understood. The nitrogen cycle is depicted in Figure 4. Bacteria denitrify NO_3^- to N_2 rapidly, and the mostly insoluble N_2 is released into the atmosphere. Fixing of nitrogen is also possible in blue-green algae whereby N_2 is eventually converted to NO_3^- or NH_4^+. However, since the N_2 molecule contains the very strong triple bond, this reaction proceeds slowly (Snoeyink and Jenkins, 1980). The reaction that yields the most energy is the reaction most favored. Denitrification of NO_3^- to N_2 as by the equation:

$$2\ NO_3^- + 12\ H^+ + 10\ e^- \longrightarrow N_2(g) + 6\ H_2O$$

has a redox potential of +21.0. Nitrate reduction of NO_3^- to NH_4^+ as in the equation:

$$NO_3^- + 10\ H^+ + 8\ e^- \longrightarrow NH_4^+ + 3\ H_2O$$

has a redox potential of +14.9. Therefore denitrification by bacteria to produce $N_2(g)$ is favored over the reduction of NO_3^- to NH_4^+ (Snoeyink and Jenkins, 1980).

Solution to Lake Elsinore's Problem

Because nitrogen and phosphorus are the nutrients which are growth limiting in the algae system, it is these two nutrients which must be controlled to control the overall system. This can be done by changing the conditions of the overall system to where an equilibrium exists between algae and bacteria. When the conditions are changed, the organisms which succeed best under the new conditions will establish a new natural steady-state system. If the new conditions are controlled properly, the new steady-state system will be one which is more acceptable to the people who are living around the lake.

For all living organisms, both nitrogen and phosphorus are essential nutrients. It is a known fact that in every environment the nutritional competition between organisms plays an important role and influences the composition of the species in that environment. The organism which succeeds best are those which use the available nutrients most readily (Rheimheimer, 1974). This fact is the one which can be exploited to re-balance the Lake Elsinore water environment to a new natural equilibrium that is more desirable.

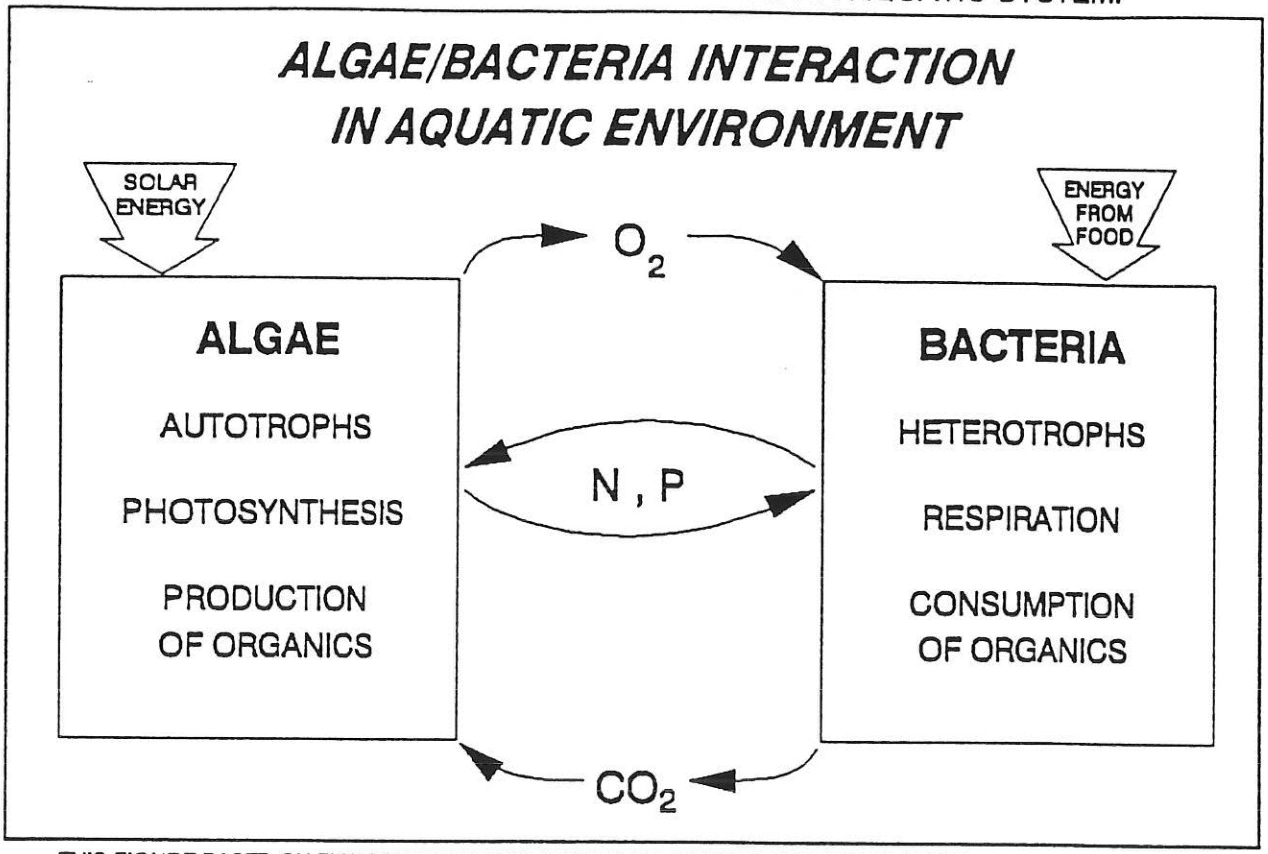
Since the growth rates of algae and bacteria are similar as noted above, the existing algae will continue to uptake nutrients, but at the same time, the large numbers of bacteria that are to be added will also uptake nutrients at similar rates. However, such large numbers of bacteria are to be added that the nutrients will be assimilated by the bacteria, and algae growth will be slowed. In addition, the existing algae will find a shortage of nutrients and die off. So, there will be a competition for the nutrients, but not in a sense that the bacteria assimilate the nutrients more quickly, but rather that the large numbers of bacteria will use more nutrients and make them unavailable to the algae.

From the photosynthesis equation, the substrates of carbon, nitrogen, and phosphorus are required by the algae in a ratio of 106:16:1. Carbon cannot be a limiting substrate since algae utilize CO_2 from the atmosphere. Nutrient levels of inorganic nitrogen and phosphorus do not significantly differ in Lake Elsinore as determined by Black & Veatch's Study of 1993. Therefore, reducing levels of available nitrogen would appear to be the most viable option since sixteen times more nitrogen is needed in photosynthesis than phosphorus. Black & Veatch also found that NO_3^- levels were the highest among inorganic nitrogen values. As noted previously, denitrification of NO_3^- to $N_2(g)$ by bacteria is favored over reduction of NO_3^- to NH_4^+, so nitrogen will be released from the lake back into the atmosphere with a large population of bacteria.

By the simple photosynthesis equation and stoichiometric computation performed above, it is evident why an initial treatment of a large number of bacteria is necessary in order to overcome the organic imbalance that has accumulated over the years in Lake Elsinore. The large initial treatment will help restore the equilibrium between algae and bacteria to consume the excess organics found in the lake.

Once the interaction of algae and bacteria is brought back into equilibrium, the bacterial growth, as well as the algae growth, will be slowed. The higher populations of bacteria will be reduced as their food source is depleted and a substrate becomes limited. With additional supplies of bacteria augmented each month in maintenance programs to maintain high populations, the algae and bacteria interaction will remain in equilibrium at an acceptable balance that minimizes algae growth and controls the availability of the nutrients.

FIGURE 1. INTERACTION OF ALGAE AND BACTERIA IN AQUATIC SYSTEM.



THIS FIGURE BASED ON FIGURE FROM STUMM & MORGAN, AQUATIC CHEMISTRY, WILEY, 1981

FIGURE 2. EUTROPHIC LAKE SYSTEM

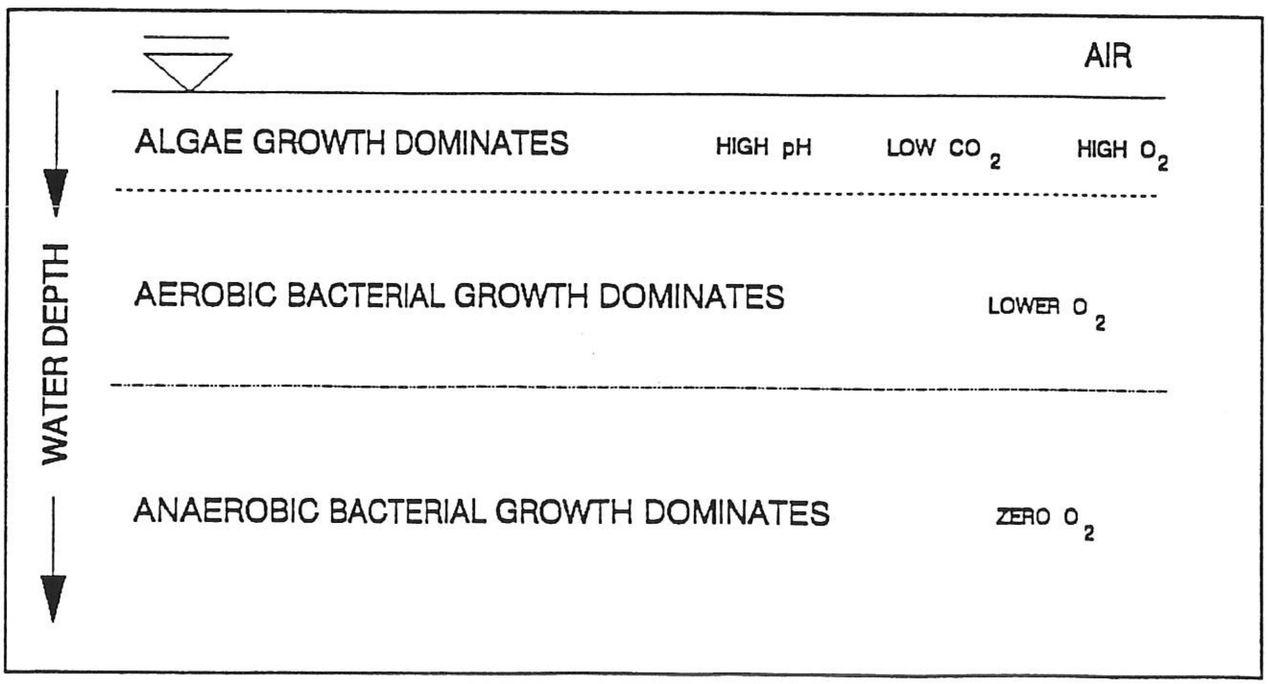


FIGURE 3. CARBON CYCLE.

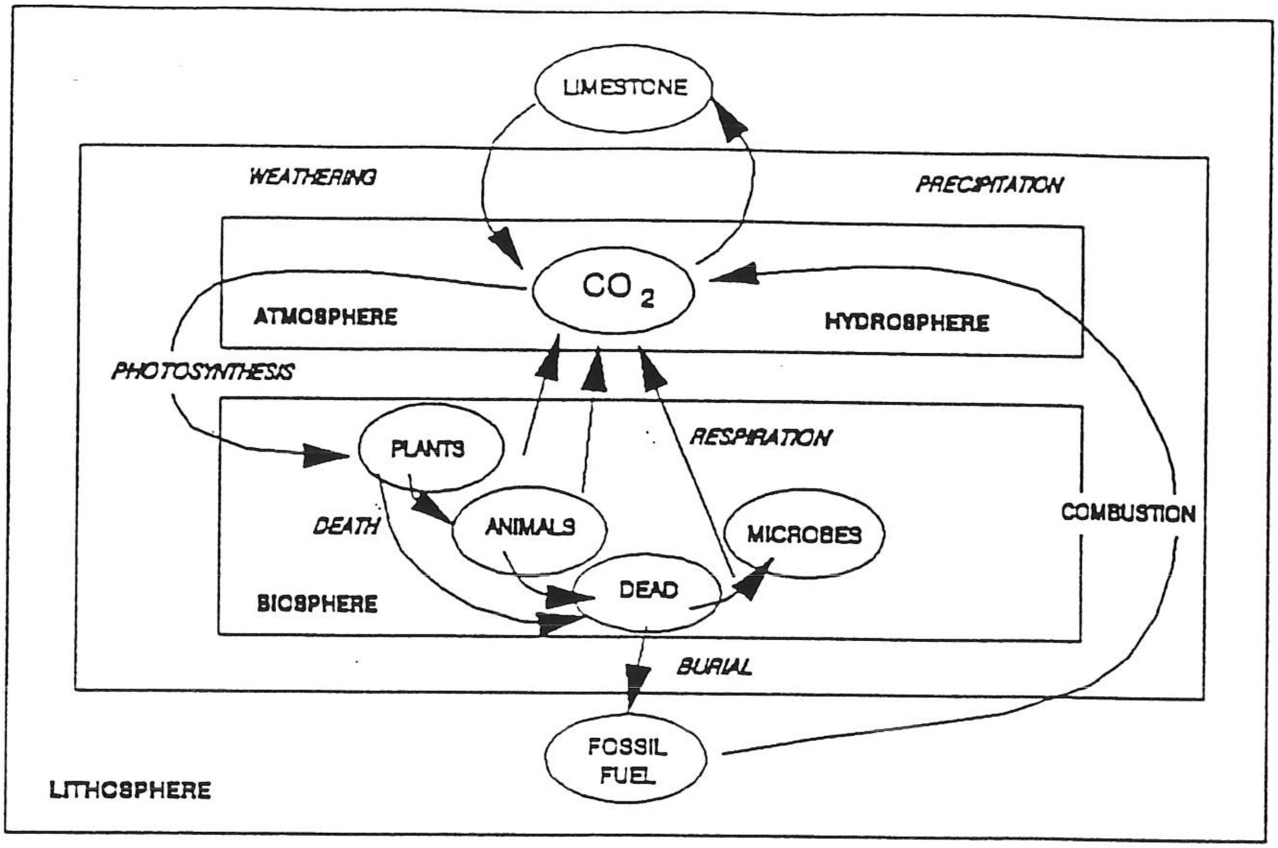
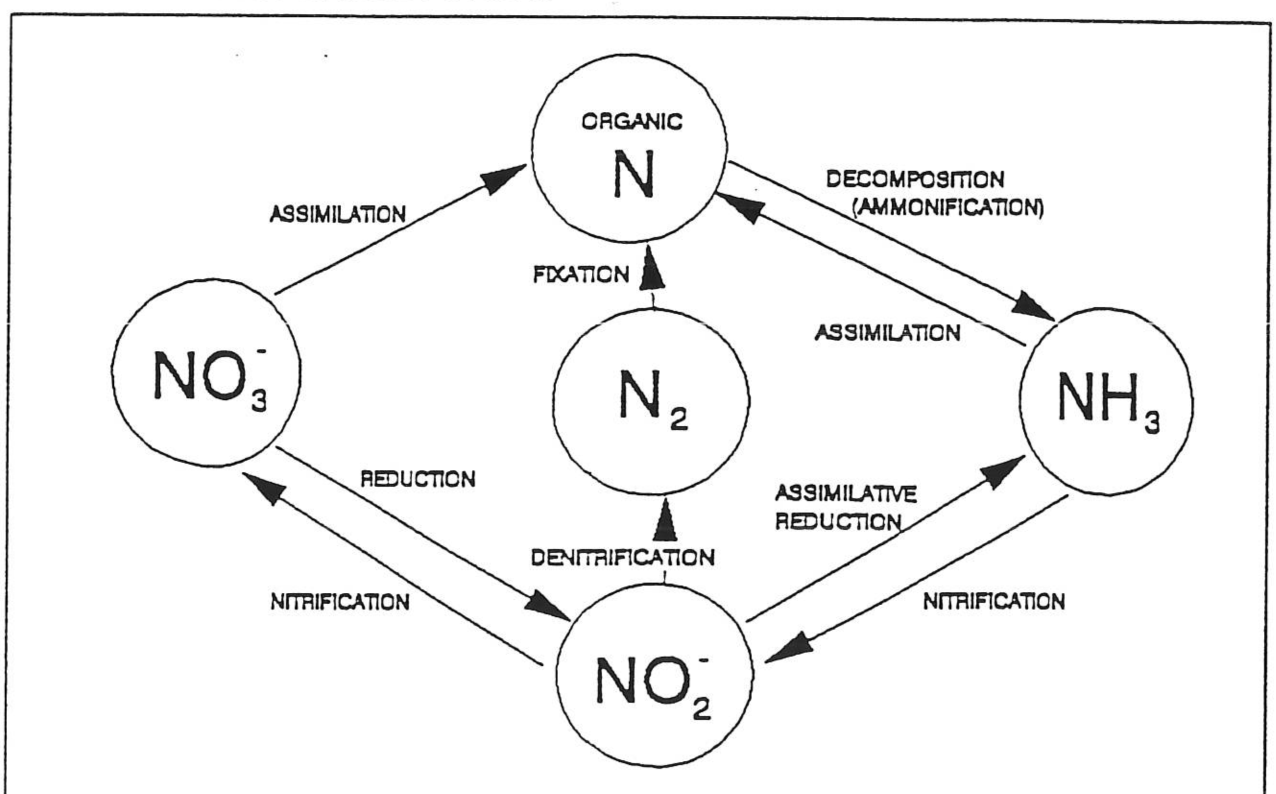


FIGURE 4. THE NITROGEN CYCLE.



ODOR CONTROL USING BIOLOGICAL METHODS

A relatively new odor control technology is that of biological removal of odor-causing compounds. This technology has found use in a number of industrial applications. Examples of these industrial uses are: rendering plant odor control, wood and pulp industry odor control, sulfur removal from flue gases of coal-burning power plants, and sewage odor control. That such a technology works and is starting to gain popularity is no surprise, since biological control of liquid and solid wastes has long been known to be the most efficient pollutant removal method.

In the case of sewage wastes, the volatile materials responsible for the objectionable sewage odors result from the biological destruction of organic solids in the waste. These offensive gases usually are created when organic materials become oxygen deficient and the degradation process switches to anaerobic respiration. The anaerobic respiration process results in four categories of odor-causing by-products:

1. The inorganic gases including hydrogen sulfides and ammonia.
2. The acids including acetic, lactic, and butyric.
3. The toxics including indole, skatole, phenols, and mercaptans.
4. The amines including cadaverine and putrescine.

These gases produced by the anaerobic respiration process have, in some cases, very low odor threshold levels, and therefore, must be reduced to very low levels or be completely removed to eliminate the odor problem. It has been found that these compounds can be biologically degraded, and that biological removal of odor-causing gases is both efficient and cost effective.

Many organisms are involved in the destruction of the odor-causing compounds. Some of the organisms found in nature that have been identified in this process are Bacillus, Pseudomonas, Escherichia, Chlorobacter, Achromobacter, Thiobacillus, Desulfovibrio, Clostridium, and Serratis. The organisms found in Enviro-Guard include many of these same species. Enviro-Guard is a stable mixture of naturally occurring microbes selected for their ability to degrade contaminants and control odors. Enviro-Guard is maintained on a composed matrix of natural organic and humic materials. Only organisms which occur naturally in the soils, surface waters, and groundwaters are present in Enviro-Guard. To a large extent, the microbes contained in Enviro-guard are aerobic, however, many facultative microbes are present so that the product is effective in both aerobic and anaerobic environments. Colony forming units per gram (cfu/g) are in the hundreds of millions. The strains of micro-organisms contained in Enviro-Guard are not altered or genetically engineered. A toxicity test was performed with Environ-Guard during February and March of 1992 by Ogden Environmental & Energy Services, Inc. using sensitive life-stage marine chronic bioassays. No toxicity was observed, chronic or acute.

Most studies which have tested biological odor control have looked at the control of hydrogen sulfide because it is both extremely toxic and has very low odor threshold. If hydrogen sulfide is controlled, in most cases, the other offending gases are also removed to below their respective threshold limits in the control process. Figure 1 shows the Sulfur Cycle as is exists in nature.

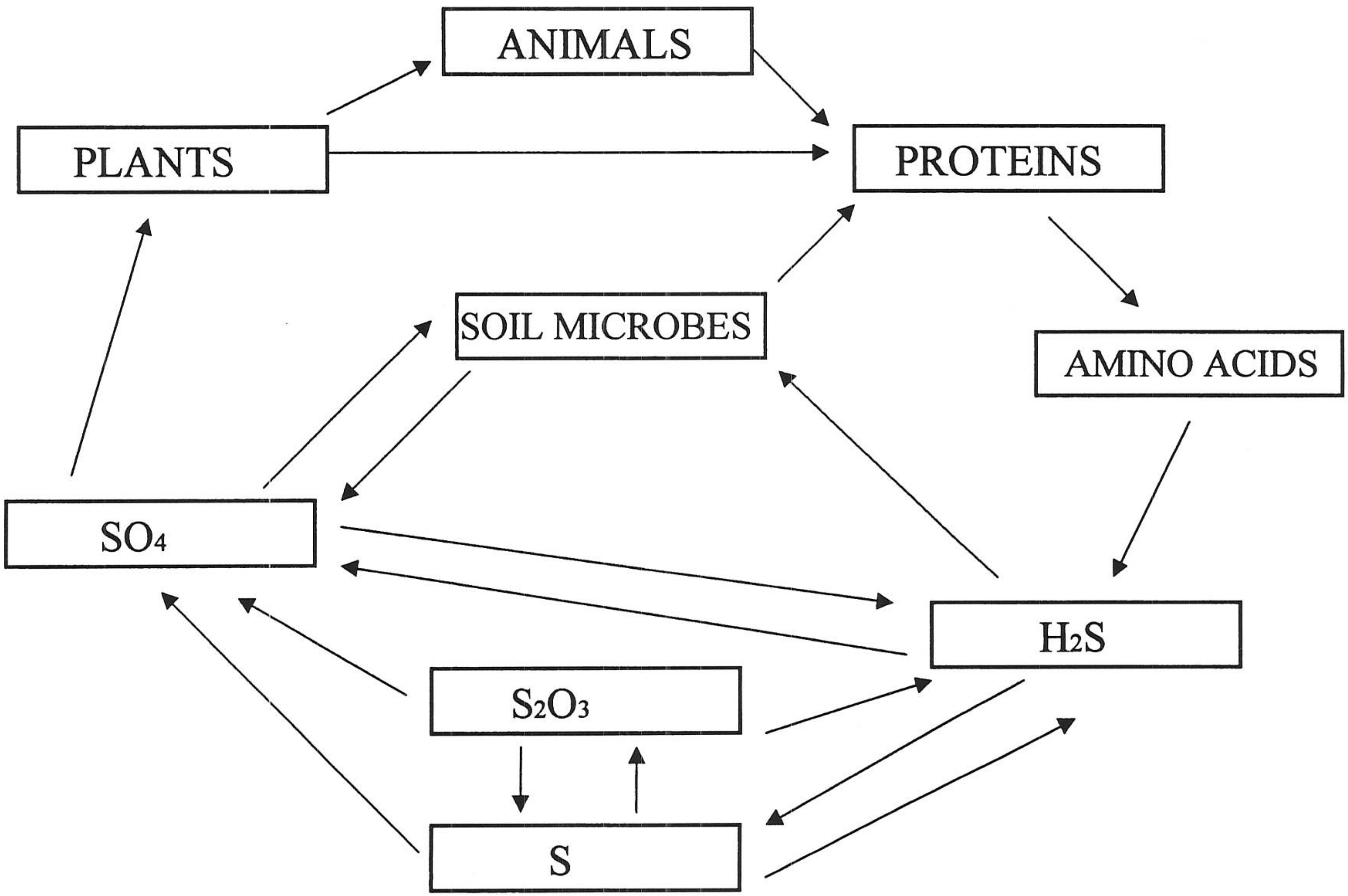
Many of the studies that tested biological control, looked at soil or compost filter systems. It was found in these studies that biological removal of odor-causing gases was not only very efficient, it was equal to the efficiency of incineration, and exceeded the efficiencies of water scrubbing and sorption techniques. Removal efficiencies of 99.9% were commonly found using biological removal technologies. The added benefit of the biological removal methods was that the technology accomplished the extremely high removals of the odor-causing gases at much lower costs for both initial set-up and continued operation.

Engineering factors which must be considered in the use of biological control of odors are: the make up and the maintenance of the microbial population, the maintenance of a proper moisture content in the filtration area, the control of the proper pH in the filtration area, the maintenance of the filtration area to prevent cracking or short-circuiting of the filter, and cover design to prevent drying or saturation as the situation deems.

Conclusion

Biological removal of odor-causing gases has been shown to be extremely efficient and at the same time very low cost compared to the other technologies which have been used in the past for odor control. In addition, biological removal of odors utilizes natural control methods which nature has been using for millions of years to control and remove the offending compounds from the environment. Using proper engineering design along with Enviro-Guard, a biological system will provide the most effective control, as well as, the lowest cost control of odor problems.

THE SULFUR CYCLE IN NATURE



BAC-TERRA™ AND TREATMENT OF EUTROPHIC LAKE SYSTEMS

THE EUTROPHIC STEADY-STATE SYSTEM:

Eutrophication is a naturally occurring steady-state system that occurs when algae growth dominates the upper lake waters, while bacterial growth dominates the lower lake waters. The steady-state system is established in a vertical layering of the lake waters during the eutrophication process. The vertical layering of the waters results because of the energy utilization systems used by the algae and the bacteria, respectively. The accompanying figure shows the processes occurring and the stratification that occurs in eutrophic systems. The figure shows that the algae side of the system uses photosynthesis, while the bacterial side of the system uses respiration. Photosynthesis operates only where solar energy input is available, and in a lake environment that is the top few feet of the lake. Respiration, on the other hand, needs organic matter to operate but is not affected by the solar energy coming into the system. In a eutrophic lake system, photosynthesis dominates the upper levels of the lake and an excess level of organic matter, in the form of algae biomass, is produced. As the algae dies and sinks, it becomes an available organic food supply for the bacteria in the deeper lake waters. Thus, the steady-state system develops in a vertical fashion as shown in the accompanying figure.

The first respiration mechanism which comes into play to utilize the abundant organic material is aerobic respiration, or in other words, respiration using the oxygen dissolved in the lake water. The dissolved oxygen in the water comes primarily from two sources. First, oxygen dissolves into the water at the surface from direct contact with the air, and second, oxygen is produced as a by-product of the photosynthesis reaction and is released by the algae into the water. As the aerobic respiration processes occur in the lake waters, they use up the dissolved oxygen. Since the dissolved oxygen is coming into the system at, or near, the surface, the amount available in the water decreases with depth. As depth increases, the amount of oxygen decreases and eventually goes to zero, and as it does so the respiration process being utilized changes from aerobic respiration to anaerobic respiration. It is the anaerobic respiration reactions occurring in the oxygen-deficient deeper waters that cause the release of odor-causing gases such as hydrogen sulfide.

As algae grow in the surface waters, they utilize the carbon dioxide that is dissolved in the water to drive the photosynthesis process, The carbon dioxide is replenished both from the air at the surface of the lake and from the carbon dioxide released in the deeper lake waters as a by-product of the respiration process of the bacteria. As a result, carbon dioxide is seldom a growth-limiting nutrient for the algae's growth, but at the same time the level of carbon dioxide dissolved in the surface waters is always at a very low level. The low level of dissolved carbon dioxide in the surface water drives the pH of the surface waters to fairly high levels. As noted earlier, the surface waters contain high levels of dissolved oxygen, and while this would normally encourage large amounts of bacterial growth, such growth does not occur in a eutrophic system. This lack of massive bacterial growth in a eutrophic lake's surface waters is the result of several factors. First, as noted above, algae blooms drive the pH of the surface water up into the 7 to 10 pH range. Most bacteria prefer a pH range of 6.5 to 8.5, and as a result, the environment created in the upper levels of a eutrophic lake is quite hostile to bacterial growth. Second, most of the organic matter in the upper levels of the lake is tied up in the living algae cells, and is, therefore, not readily available to the bacteria. Any organic matter that is available in the upper levels of the lake is used up in the highly oxygenated waters, and therefore, the system is often carbon limited for bacteria. Since the algae are utilizing photosynthesis and carbon dioxide, they are not limited in this environment and can continue to grow unchecked.

As the eutrophic system develops and establishes a steady-state system, the nutrients which become growth limiting to the algae are nitrogen and phosphorus. This is why phosphorus-based soaps or nitrogen- and phosphorus-rich agricultural runoff can cause such significant eutrophic conditions to occur in rivers and lakes. The secret then to controlling algae growth in lakes is in being able to control the availability of the two nutrients, nitrogen and phosphorus.

To summarize, a eutrophic environment has massive algae growth in the upper level waters of a lake. The upper levels are also characterized by high dissolved oxygen, low dissolved carbon dioxide, and high pH values. With increasing depth, the dissolved oxygen levels quickly decrease and go to zero, the bacterial levels increase, and the amount of available organic nutrients in the form of decaying biomass increase. The respiration reactions are aerobic at the surface and change to anaerobic at deeper levels. The anaerobic reactions occurring in the deeper waters result in release of odor-causing gases which cause the smells associated which eutrophic conditions. In the upper levels of the lake, the rate-limiting nutrients for the algae are phosphorus and nitrogen, and the limiting nutrient for the bacteria is the available carbon. At deeper levels, the limiting factors for growth of the algae is the available solar energy and the limiting factor for growth of bacteria is first, oxygen -- growth changes to anaerobic as the oxygen runs out -- and second, the available carbon.

DISRUPTING THE EUTROPHIC STEADY-STATE SYSTEM:

Because a eutrophic lake is a steady-state system, the only way to effect a change is to disrupt the system. As the accompanying figure shows, a number of physical, chemical, and biological cycles are at work in a eutrophic system. This allows a number of ways to interact within the system and thereby disrupt the system, stopping the eutrophic steady-state system.

Since the growth of the algae in a lake drives the lake environment towards a eutrophic steady-state system, and then helps maintain that steady-state system, it is essential to stop the growth of the algae to disrupt the eutrophic cycle. Bacteria grow at a much higher rate of growth than algae do. As a result, bacteria will consume nutrients at a much faster rate than algae. Therefore, if a large number of bacteria are added to the surface waters of a eutrophic lake they will consume the rate-limiting nutrients, nitrogen and phosphorus, much faster than the algae, and as a result, the algae will stop growing and will die.

If the bacterial addition is not large enough, or if it is only a one-time addition, the hostile environment of the surface waters will stop the bacteria from growing and the eutrophication cycle will re-establish itself. By periodic addition of actively growing aerobic bacteria to the surface waters, the phosphorus and nitrogen are used by the bacteria instead of the algae and the algae dies. This results in the carbon dioxide levels rising in the surface waters, and consequently, the pH levels dropping back to non-hostile pH levels, levels that are more favorable to bacterial growth.

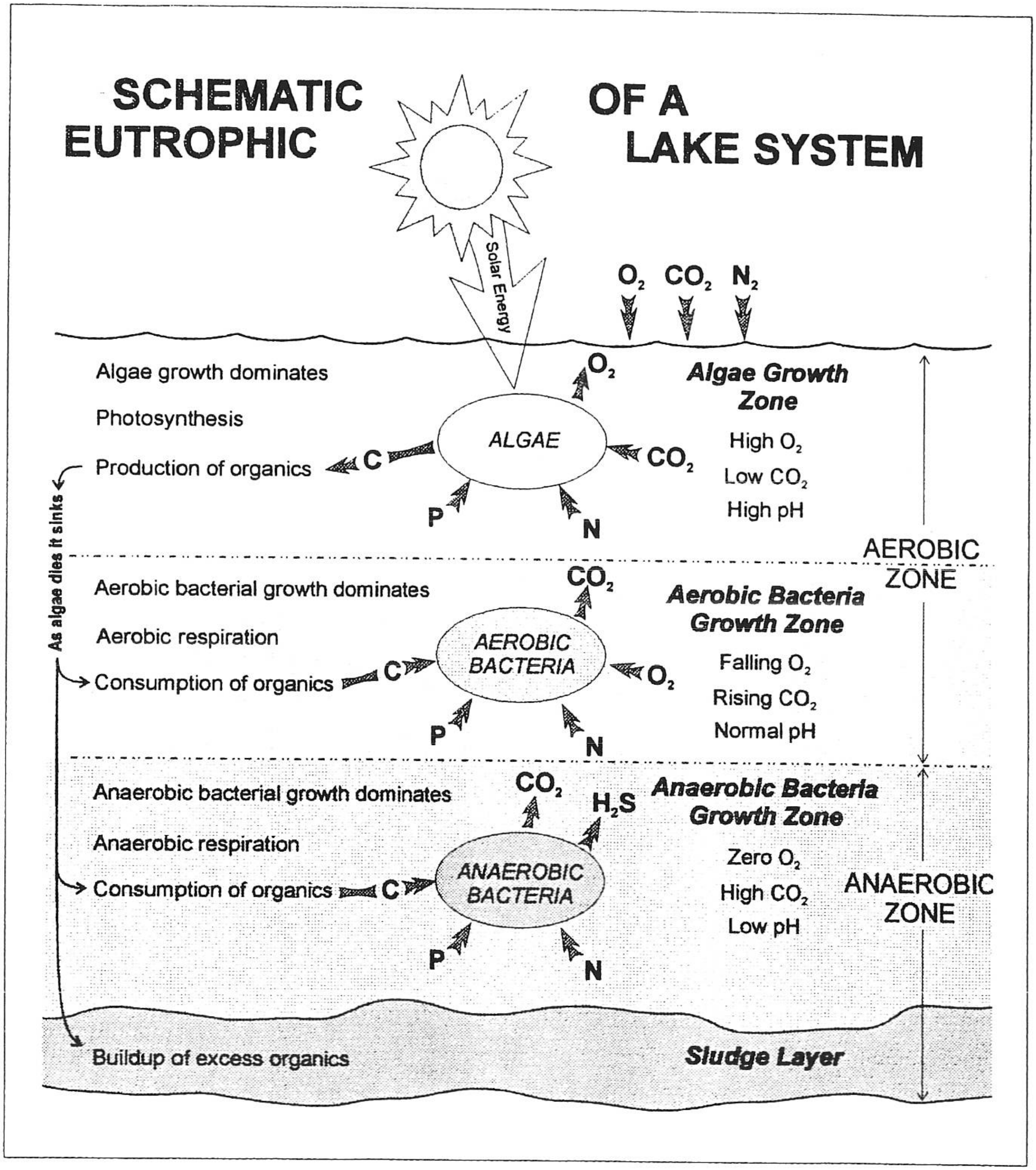
The last item needed in the surface waters to ensure good bacterial growth success is adequate organic carbon. This organic material can be added with the bacterial culture.

WHY BAC-TERRA™ TREATMENT ACCOMPLISHES EUTROPHIC DISRUPTION:

Bac-Terra™ contains a large number of organisms and a wide variety of species. Bac-Terra™ will, therefore, provide the mass loading and the biodiverse mix of organisms needed to consume the nutrients on which the algae grow.

Bac-Terra™ product contains organic nutrient materials in the compost-like matrix on which the bacterial cultures are maintained. When Bac-Terra™ is steeped in water prior to being added, the organic materials are released into the solution, and they help provide a short-term microenvironment that favors bacterial growth over algae growth. Additionally, the Bac-Terra™ solution contains buffers that control and maintain the pH at proper levels for bacterial growth, and this further enhances the microenvironment favorable to bacteria.

Since eutrophication is a natural steady-state system, a lake will always move toward eutrophic conditions unless an active program is set up to re-balance the lake system in a non-eutrophic condition. Bac-Terra™ treatments lend themselves very conveniently to a systematic maintenance program. Additionally, we at Enviro-Lab, Inc. understand both the nature of the eutrophication process and how to interact and disrupt the eutrophication process using Bac-Terra™.


SCHEMATIC OF A
EUTROPHIC LAKE SYSTEM
Solar Energy
O_2 CO_2 N_2
Algae growth dominates
Photosynthesis
Production of organics
C
ALGAE
O_2
CO_2
P
N
Algae Growth Zone
High O_2
Low CO_2
High pH
As algae dies it sinks
Aerobic bacterial growth dominates
Aerobic respiration
Consumption of organics
C
AEROBIC BACTERIA
CO_2
O_2
P
N
Aerobic Bacteria Growth Zone
Falling O_2
Rising CO_2
Normal pH
AEROBIC ZONE
Anaerobic bacterial growth dominates
Anaerobic respiration
Consumption of organics
C
ANAEROBIC BACTERIA
CO_2
H_2S
P
N
Anaerobic Bacteria Growth Zone
Zero O_2
High CO_2
Low pH
ANAEROBIC ZONE
Buildup of excess organics
Sludge Layer

SUMMARY OF VARIOUS STUDIES USING BAC-TERRA TO TREAT PROBLEMS IN SEWAGE, HOG LAGOONS, SLAUGHTER FACILITIES.

Letter #1 –

Study One:

This study shows the reduction of hydrogen sulfide in both air and solution I 24 hours yielding a true reduction in mal odors.

Study Two:

This study showed qualitatively a reduction in hydrogen sulfide odors and a dramatic reduction in nitrates.

Study Three:

This study resulted in the pond odor being gone in 72 hours and a COD (Chemical Oxygen Demand) reduction from 3120 ppm to 170 ppm in 14 days.

Letter #2 –

This letter references a study done at a Poultry processing plant. The test results showed a reduction of total nitrogen, a reduction of total potassium and a reduction of hemoglobin.

Letter #3 –

This letter illustrates the ability to reduce Fecal Coliform in river water. Fecal Coliform was reduced from 4,000 colonies per 100 ml down to 100 colonies per 100 ml in 48 hours.

Letter #4 –

This analytical data was derived from a test done on a Landfill Condesate lagoon. Not only was there a drastic reduction in the methane and benzene, but there was also a reduction in Nitrates (NO_3).

Letter #5 –

The date listed in this letter is the result of testing done on Pig Waste. The results indicate a reduction in Staphylococcus organisms and E. Coli organisms. The level of reduction of E. Coli organisms is dramatic.

Letters #6 –

These four reports illustrate the reduction in Fecal Coliform in both an influent and effluent wastewater stream.

Letters # 7, 8, 9 –

These letters are testimonials from various cities citing favorable results.

Fifco International, Inc.
1011 Camino Del Mar, Suite 240
Del Mar, California 92014
[redacted]
E Mail: Bac-Tera@ix.netcom.com

11 February 1997

[redacted]

Re: **Bac-Terra®** treatment for sewage and waste water

Dear [redacted]

I am pleased to provide you with information regarding the test results of several waste water treatments: City of Oceanside, Eastern Municipal Water District's Moreno Valley Plant and the City of Lake Charles, Louisiana Plant.

City of Oceanside, California. The City of Oceanside wanted to determine if the addition of **Bac-Terra®** would reduce or eliminated the need for chlorine type treatments in the trunk lines as well as at their treatment facility. The first phase was a bench test at the site. 20 gallons of raw influent were placed in each of 2, 55- gallon drums. Each would be stirred 12 times per day to simulate some trunk line movement. One quarter pound of dry **Bac-Terra®** was placed in only one of the barrels. **Readies of the** hydrogen sulfide (H_2S) were taken throughout the next 24 hours in both the air and solution the determine true reduction in this mal odor. The results were:

0930- initial	air--351 ppb;	solution 5.0 ppm
1700	air--174 ppb;	solution 2.0 ppm
0730	air-- 71 ppb;	solution 0.0 ppm.

The second phase of this was an in field treatment test. I have enclosed the preliminary proposal and resulting purchase order for your review.

Lake Charles, Louisiana. The City of Lake Charles sewage facility was continuing to freeze up due to extensive amounts of grease build up throughout their plant. Their supplier, United Labs contacted us to see if **Bac-Terra ®** would help. We met with City officials and agreed to a week long pilot test, with daily data to be supplied for our review. 2 pounds of **Bac-Terra ®** were placed only in each primary clarifier on a daily basis. The system was monitored throughout. The following results were noted: dramatic reduction in grease build up, unfreezing or unstopping of their plugged anaerobic digestors, removal of hydrogen sulfide odors throughout plant and overflow ponds and a dramatic reduction in nitrate at the effluent stage. The treatment began 2 February and continued for 7 days. readings were taken for 30 days to determine the stage at which additional **Bac-Terra®** treatment would be necessary

Eastern Municipal Water District's Moreno Valley Treatment Plant. EMWD was being sued for H2S air quality violations and requested that we treat their overflow ponds, grease interceptor, and belts press for H2S reductions and grease elimination. Treatments began and lasted for 30 days. The results noted were: pond odor gone in less than 72 hours, blood worm recurrence within 10 days, COD reduction from 3,120 ppm to 170 ppm within 14 days (even with an additional spill into the pond of 5 million gallons of raw influent due to a digestor plug up; grease interceptor was treated with dry **Bac-Terra®** to eliminate 3 foot grease mat which had covered of frozen up the mercury switches, our treatment eliminated the problem within 7 days completely allowing the flow of digested material to go directly to the digestors; the belt press was treated at their weir holding tank with dry **Bac-Terra®** just after release from the digestor and before the belt press, resulting in complete removal of H2S and the subsequent improvement in belt life and efficiency.

Each of these clients have requested that their confidentiality be maintained. They do not wish to receive any inquiries regarding their operations from anyone They have allowed their information to be studied by us for understanding, only. This information is, therefore, not to be reproduced for any reason or handed out to anyone. It is for your understanding and edification.

If I can be of further assistance, please contact me.

Sincerely,

John Bullington, President
Fifco International, Inc.
Manufacturer, **Bac-Terra® Products**

Bac-To-Clean, Inc.

Post Office Box 93
Boonville, Missouri 65233

FEBRUARY 25, 1993

JOHN BULLINGTON
FIFCO INTERNATIONAL, INC.
1011 CAMINO DEL MAR # 240
DEL MAR, CA. 92014

DEAR JOHN,

I AM ENCLOSING A COPY OF THE LAB RESULTS FROM THE SIMMONS POULTRY PROCESSING PLANT IN SOUTHWEST CITY, MO.

AS YOU ARE AWARE WE HAVE BEEN TESTING IN THIS FACILITY FOR ABOUT TWO WEEKS TRYING TO REDUCE THE SLUDGE FROM THEIR DIFFUSED AIR FLOW SYSTEM. SINCE OUR SUCCESS WAS MINIMAL I DECIDED TO RUN TEST ON OTHER POSITIONS WITHIN THE SYSTEM TO SEE WHERE WE MIGHT BE OF MORE BENEFIT. THE SAMPLE THAT THIS TEST RELATES TO WAS TAKEN FROM THE WETWELL DIRECTLY BELOW THE PROCESSING FLOOR. THIS WELL COLLECTS LARGE AMOUNTS OF BLOOD, CHICKEN PARTS AND METAL SHAVINGS.

THE PLANTS MAIN FOCUS FOR WATER TREATMENT ARE BLOOD, GREASE AND TKN(TOTAL NITROGEN AND POTASSIUM) , IN THE NEAR FUTURE AMMONIA TESTING WILL BE REQUIRED. THIS TEST DEALT SPECIFICALLY WITH THE TKN AND BLOOD WHICH SHOWS AS PERCENTAGE OF HEMOGLOBIN.

THE TEST SHOWS THAT WE REDUCED TOTAL NITROGEN BY 100 PPM, POTASSIUM BY 50 PPM, AND THE HEMOGLOBIN FROM 197 PPM TO A LEVEL BELOW THE DETECTION LIMIT. I WAS SURPRISED AT THE SMALL REDUCTION IN TKN SO I HAD THE UNTREATED SAMPLE CHECKED FOR CHLORINE SINCE ALL CLEANUP RUNOFF FLOWS INTO THIS WETWELL ALSO. WHAT WE FOUND WAS A LEVEL OF 200 PPM WHICH IS MORE THAN SUFFICIENT TO KILL OUR BACTERIA. THE FACT THAT WE REDUCED THE BLOOD TO BELOW DETECTION AND TKN BEFORE WE WERE KILLED I FEEL SHOWS THE SPEED IN WHICH OUR BACTERIA WORK. IN OTHER TESTING I HAVE SEEN THE BLOOD REDUCED IN LESS THAN 15 MINUTES SO I WOULD ASSUME THAT WAS CLOSE TO THE AMOUNT OF TIME OUR BACTERIA SURVIVED IN THIS TEST.

THESE TEST RESULTS HAVE SUFFICIENTLY IMPRESSED THE PLANT TO RESUME TESTING IN OTHER AREAS. IN THEIR SYSTEM THEY ADD FERRIC AND A ANIONIC POLYMER IN ORDER TO FLOAT SOLIDS TO THE SURFACE FOR SKIMMING. I HAVE FOUND THAT IN ORDER TO GET THE BEST USAGE FROM OUR BACTERIA THAT WE SHOULD INTRODUCE IT AFTER THE DIFFUSED AIR FLOW SYSTEM AND ADD IT IN THE LAGOONS. WE ALSO TRIED ADDING TO THE INFLUENT LINES BUT FOUND SPIKES OF CHLORINE KILLED OUR BACTERIA ALSO. I FEEL THAT BY TREATING THE LAGOONS ANY SPIKES OF BLOOD OR GREASE CAN BE SUFFICIENTLY HANDLED AND THAT THE CHLORINE SPIKES WILL BE SUFFICIENTLY DILUTED AND THEIR EFFECT UPON OUR PRODUCT WILL BE MINIMAL.

UNIVERSITY OF MISSOURI-COLUMBIA

College of Agricultur

Experiment Station Chemical Laboratories
and Interdisciplinary Chromatography
Mass Spectrometry Facility

Room 4 Agriculture Building
Columbia, Missouri 65211
Telephone (314) 882-2608

February 18, 1993

Mike Stuck
Bac-To-Clean, Inc.
P.O. Box 93
Boonville, MO 65233

Dear Mr. Stuck:

The following report covers the analyses on the samples of sludge which you submitted to the Experiment Station Chemical Laboratories for analysis. The samples were received on January 25, 1993.

Laboratory Sample No.	Your Identification	Analyzed for	% Found
93-3471	untreated	Total Nitrogen (N)	0.04
		Potassium (K)	0.0065
		Chloride (Cl)	0.02
		Hemoglobin	0.197
93-3472	treated	Total Nitrogen (N)	0.03
		Potassium (K)	0.0060
		Hemoglobin	<0.012

A University of Missouri Invoice will be sent to you by the Accounting Department for payment of these services.

We are glad that we have been able to make these analyses for you.

ESCL
Agriculture Experiment Station
Experiment Station Chemical Laboratories
University of Missouri-Columbia

Sincerely,

Rhonda L. Boles
Supervisor Fertilizer Laboratory

Dr. Thomas P. Mawhinney
Director

BAC-TO-CLEAN, INC.
P.O. BOX 93
BOONVILLE, MO 65233
1-800-485-5087

AUGUST 3, 1993

MISSOURI D. N. R.
FLOOD CO-ORDINATOR
OGLE HOPKINS
P.O. BOX 176
JEFFERSON CITY, MO 65102

MR. HOPKINS,

I AM ENCLOSING A COPY OF THE LAB ANALYSIS FOR FECAL COLIFORM. THESE SAMPLES WERE DRAWN FROM BACK WATER OF THE MISSOURI RIVER ON 2ND. STREET HERE IN BOONVILLE. THE SAMPLE WAS TAKEN AT 3 PM TUESDAY JULY 27, 1993. THE SAMPLES WERE TAKEN TO THE LAB ON THURSDAY JULY 27, 1993 AT APPROXIMATELY 1:30 PM WHERE THE TESTING STARTED SOON AFTER.

SAMPLE A IS UNTREATED WATER AS FOUND AT LOCATION.
TEST RESULTS 4000 COLONIES PER 100 MIL.

SAMPLE B IS WATER TREATED WITH "BAC-TERRA"tm ON TUESDAY
RIGHT AFTER SAMPLE WAS TAKEN.
TEST RESULTS 100 COLONIES PER 100 MIL.

SAMPLE C IS WATER TREATED WITH "BAC-TERRA"tm AT 1:00 PM ON
THURSDAY JUST BEFORE TAKING IT TO THE LAB.
TEST RESULTS 2700 COLONIES PER 100 MIL.

AS SEEN BY THE ANALYSIS THE FECAL COLIFORMS WERE REDUCED BY 97% BY TREATING WITH "BAC-TERRA"tm, IN APPROXIMATELY 48 HOURS (Sample A: vs. Sample B:)

ALSO IT SHOWS THAT THERE WAS A 32% REDUCTION IN FECAL COLIFORMS WITHIN A MATTER OF A FEW HOURS AFTER TREATMENT WITH "BAC-TERRA"tm. (Sample A: vs. Sample C:)

I HOPE THIS WILL HELP SHED SOME LIGHT AS TO WHY WE FEEL "BAC-TERRA"tm CAN BE SO BENEFICIAL TO THE CLEANUP OF OUR STATE.

'INEERING SURVEYS AND SE CES
TING LABORATORY
1113 Fay Street • Columbia, Missouri 65201 • (314) 449-2646
802 El Dorado Drive • Jefferson City, Missouri 65101 • (314) 636-3303

Date: 03 August 1993

Lab No. 3508

Project: Bac-To-Clean

Location: Boonville, Missouri

Date Received: 29 July 1993

Sample No./ Description:
6314 / Sample A
6315 / Sample B
6316 / Sample C

TEST RESULTS

PARAMETER	METHOD	SAMPLE NUMBER 6314	6315	6316	DETECTION LIMIT
Fecal Coliform, #/100 ml	9222 D	4,000	100	2,700	1

Note: Sample secured and delivered to lab by others.

Method number from Standard Methods for the Examination of Water & Wastewater, 18th Edition, unless otherwise noted.

CC: 1 Stuck

ENGINEERING SURVEYS AND SERVICES
BY: [signature]
David A. Bennett

[redacted] / [redacted]

LANDFILL CONDENSATE PILOT PROJECT

UTILIZING BAC-TERRA™ BR-650

Analytical Test Data
April 1995

Compound	Untreated	96/hr Sample
Total Alkalinity	340 ppm	240
Nitrate, as NO_3	0.62 ppm	N/D
Total Anions	350 ppm	258
Alumium	0.59 ppm	N/D
Silver	0.55 ppm	N/D
Chloromethane	12,000 ppb	N/D
1,2-Dichlorobenzene	11,000 ppb	N/D
1,4-Dichlorobenzene	2,600 ppb	7.9
cis-1,2-Dichlorethene	1000 ppb	5.0
Benzene	1000 ppb	110
Polychlorinated Biphenyls PCB's (1232)	110 ppb	N/D

ASSOCIATED LABORATORIES

806 North Batavia · Orange, California 92868 · 714/771-6900 FAX 714/538-1209

CLIENT

Fifco International, Inc. (3224)
P.O. Box 312
Del Mar, CA 92014-0312

Attn: Gaye Garcia

LAB NO F67138

REPORTED 06/23/89

SAMPLE Solid/Liquid

RECEIVED 06/16/89

IDENTIFICATION As Below

BASED ON SAMPLE As Submitted

	Sample #1 A Untreated Pig Waste	Sample #2 Bio-Septic Treated Pig Waste
Staphylococcus	< 10	< 1
E. Coli	> 1,600,000	300,000
Salmonella	Negative	Negative

ASSOCIATED LABORATORIES

Tito L. Parola

TLP/mmf

---- DUANE R BRACH

ern Municipal Water District Laboratory
acteriological Analysis Report

tory

-1?00

Dist. Off. (714) 925-7676
Dist. Lab. (714) 654-4418

t. Off. (714) 925-7676
t. Lab. (714) 654-4418

24-1

'91

Type of Sample: Wastewater
Samples by: Brach (Bacterra)
Account Number: 03205646364000
Set-Up: Date/Time 1100 on 5/24
Untreated Influent

Wastewater
Brach (Bacterra)
03205646364000
1115 on 5/24

	Number of Tubes TC+	FC+	MPN/100mL Total Coliform	Fecal Coliform
+ + + + +				
+ + + + +	5	5	>16,000,000	>16,000,00
+ + + + +				
+ + + + +				
+ + + + +	5	5		
+ · + + +				
+ + + + +	5	5		
+ · + + +				
+ + + + +				
- - - - -				
- - - - -				
- - - - -				
- - - - -				
- - - - -				
- - - - -				
- - - - -				
- - - - -				
- - - - -				
- - - - -				

MPN/100mL tal liform	Fecal Coliform
6,000,000	8,000,000

Approved by

pproved by

06/03/1991 07:50 FROM DUANE A BRACH TO JOHN B

6-3-91

21.15T

Eastern Municipal Water District Laboratory
Bacteriological Analysis Report

). Box 8300
ı Jacinto, CA 92383-1300

Dist. Off. (714) 925-7676
Dist. Lab. (714) 654-4418

). Number: 91052403
:e Collected: 5/23/91
juested by: Brach
nple Number:
ıple Location: MVTC Untreated Effluent
-R: T= F=
ı3: Temp: C

Type of Sample: MV Wastewater
Samples by: Brach (Bacterra)
Account Number: 03205646364000
Set up: Date/Time: 5/24 @ 1300

lution				Number of Tubes TC+	FC+	MPN/100mL Total Coliform	Fecal Coliform
001mL	LTB	24hr.	+ + + + +				
	LTB	48hr.					
	BGLB	24hr.	+ + + + +	5	3	500,000	140,000
	BGLB	48hr.					
	ECM	24hr.	+ - - + +				
0001mL	LTB	24hr.	- - + - +	2	2		
	LTB	48hr.	- - -				
	BGLB	24hr.	+ +				
	BGLB	48hr.					
	ECM	24hr.	+ +				
00001mL	LTB	24hr.	- - - - -	0	0		
	LTB	48hr.	- - - - -				
	BGLB	24hr.					
	BGLB	48hr.					
	ECM	24hr.					
001 mL	LTB	24hr.	- - - - -				
	LT[illegible]	[illegible]	- - - - -				
	B.LB	24hr.	- - - - -				
	BGLB	48hr.	- - - - -				
	ECM	24hr.	- - - - -				
.0001 mL	LTB	24hr.	- - - - -				
	LTB	48hr.	- - - - -				
	BGLB	24hr.	- - - - -				
	BGLB	48hr.	- - - - -				
	ECM	24hr.	- - - - -				

otes:

JCR AJ
Analyst (s)

[signature]
acting in absence of

1-67

A-21.15T

Eastern Municipal Water District Laboratory
Bacteriological Analysis Report

.O. Box 8300
an Jacinto, CA 92383-1300

Dist. Off. (714) 925-7676
Dist. Lab. (714) 654-4418

ab. Number: 91052404
ate Collected: 5/23/91
equested by: Brach
ample Number:
ample Location: MVTC Treated Effluent
l-R: T= F=
ime: Temp: C

Type of Sample: Wastewater
Samples by: Brach/Bacterra
Account Number: 03205646364000
Set-Up: Date/Time 5/24 @ 1300

ution	Medium	Time	Tubes	TC+	FC+	MPN/100mL Total Coliform	MPN/100mL Fecal Coliform
[illegible]mL	LTB	24hr.	+ + + + +	5	1	800,000	20,000
	LTB	48hr.					
	BGLB	24hr.	+ + + + +				
	BGLB	48hr.					
	ECM	24hr.	- + - - -				
.0001mL	LTB	24hr.	- - - - +	3	0		
	LTB	48hr.	- - + +				
	BGLB	24hr.	- + +				
	BGLB	48hr.	+				
	ECM	24hr.	- - -				
.00001mL	LTB	24hr.	- - - - -				
	LTB	48hr.	- - - - -	0	0		
	BGLB	24hr.					
	BGLB	48hr.					
	ECM	24hr.					
mL	LTB	24hr.	- - - - -				
	LTB	48hr.	- - - - -				
	BGLB	24hr.	= = = = =				
	BGLB	48hr.	- - - - -				
	ECM	24hr.	- - - - -				
mL	LTB	24hr.	_ _ _ _ _				
	LTB	48hr.	_ _ _ _ _				
	BGLB	24hr.	_ _ _ _ _				
	BGLB	48hr.	_ _ _ _ _				
	ECM	24hr.	_ _ _ _ _				

tes:

JCR AJ KM
Analyst (s)

Approved by

CITY OF EUDORA

P.O. BOX 650
EUDORA, KANSAS 66025
PHONE (913) 542-2153

December 8, 1993

Jim Lewis
Enviro-Lab
10580 Barkley, Suite 62
Overland Park, Ks. 66212

Dear Jim,

This letter is forwarded in acknowledgement of our satisfaction with Bac-Terra. Prior to our treatment with Bac-Terra, we had grease balls floating in the lagoon, the water was black due to poor flocculation, and the odor for H_2S was creating complaints from the residents of Eudora. There was also a green slime that covered the lagoon, creating algae problems. We were continually adding hydrogen peroxide to enhance the oxygen levels of the lagoon.

The use of Bac-Terra eliminated the grease balls and the green slime. Oxygen levels were increased, enhancing the flocculation. Our test reports have shown a significant decrease of BOD and increase in dissolved oxygen concentrations.

We are treating with Bac-Terra on a daily basis at the industrial park, located approximately 2 miles from the lagoon. The product is added at a nearby lift station. The trunk line was continuously septic due to the slow movement of sewage from the lift station to the lagoon. Since application, the odor in the trunk line has subsided and we have had no further complaints from the residents.

I would recommend your product to any waste-water treatment facility wanting to improve their systems.

Sincerely,

Gary Malburg
Superintendent

HARRY M. MAYS
County Administrative Officer

COUNTY OF SAN BERNARDINO

County Administrative Office

No. 1 Arrowhead Plaza, 5th Floor
385 North Arrowhead Avenue
San Bernardino, CA 92415-0120
(909) 387-5418
Telecopier (909) 387-5430

September 15, 1993

John Bullington, President
BAC-TERRA
Fifco International, Inc.
1011 Camino Del Mar, #240
Del Mar, CA 92014

Dear Mr. Bullington:

Unfortunately, I was unable to attend your meeting last week on the use of Bac-Terra for bioremediation. As you know, I am a strong proponent of bioremediation and see it as the future of contamination cleanup and also as an important element for use in agriculture, health-related industries, and particularly the degradation of unwanted waste.

The experience that we have had in San Bernardino County, while limited, has been positive. We have seen the application of bacteria reduce hydrocarbons in petroleum spills and also speed up the reaction and eliminate the smell and flies in septic ponds. In a number of your other projects, I have seen the bacteria clean up plumes of petroleum hydrocarbons located under cement and eliminate and control the growth of algae in ponds and nursery hot houses.

I am certainly a supporter of bioremediation and also of your product Bac-Terra. We look forward to doing business with you in the future.

Sincerely,

HARRY M. MAYS
County Administrative Officer

HMM:lu

Pinewood Sewer Company, Inc.

CORPORATE OFFICE
608 W. Frontier Street
P.O. Box 339 • Payson, Arizona 85547 • (602) 474-2100
Phoenix Line: 254-2330

December 1, 1993

Mr. John Bullington
FIFCO International, Inc.
1011 Camino Del Mar, #240
Del Mar, CA 92014

RE: Result of BAC-TERRA Application at Sewage Effluent Ponds

Dear Mr. Bullington:

The purpose of this letter is to report to you our satisfaction with the application of BAC-TERRA to the effluent holding ponds on the golf course adjacent to our treatment plant. As a result of the application, and subsequent improvement in the pond quality, the Purchaser of our facilities in this location was willing to remove a condition precedent to the sale which related to the quality of the ponds, which were impacted by sludge build-up from our facility over the past several years.

As a result of this application I would be pleased to recommend the use of BAC-TERRA to entities considering its application, and if the need arises in the future, we will certainly be confident in using the product again. Thank you for your assistance in resolving our problem, and best wishes in your future endeavors.

Very truly yours,

Richard S. Williamson, P.E.
President

RSW:ms

Ease of Application:

The tests have shown that Enviro-Guard can be applied at various stages of the operation. In the cases of a Swine Operation, Enviro-Guard can be spray applied in the houses themselves, lowering foul odors and ammonia. Enviro-guard would then end up in the lagoon via the operations normal flushing system. Mature lagoons should be treated initially in order to curb odors and start the remediation process.

For feedlot operations, Enviro-Guard can be sprayed directly onto the pens. This will allow the product to start working on waste. In addition, direct spraying onto the lagoon will start the remediation process. This should reduce odors and solids.

In poultry operations, Enviro-Guard should be sprayed directly on the poultry litter. This should reduce the ammonia level normally seen is confinement broiler and layer operations.

TEST PROTOCOL

Recoverable Resources
Test Program

I. Objective

a. To test Enviro-Guard on animal waste at various hog, cattle, poultry and slaughter facilities.
b. Evaluate the benefits of Enviro-Guard on animal waste and the environment.
c. Calculate cost and treatment methods using the product in all applications.
d. Develop a strategy for RRI to distribute Enviro-Guard in all areas of high density animal rearing.

II. Testing Protocol

A strict testing protocol, specific for each target, will be written in order to ascertain the results of treating animal waste with Enviro-Guard.

a. Specific testing criteria for:
   1. Nitrate
   2. Phosphate
   3. Pathogen
   4. BOD
   5. COD

b. Testing Cost – The approximate cost to run a trial is listed below.
   1. Sample testing at 0 hours, 1 hour, 2 hours, 4 hours, 12 hours, 24 hours, 48 hours, 72 hours, 96 hours, 7 days, 14 days, 21 days, 28 days. It I also our belief that we should continue to check the lagoon each month thereafter for 11 months. A total of 24 tests having an analytical and biological cost of $175 per test. In addition, a great deal of time and funding will be necessary to administer the protocols and evaluate the data.

      Projected total cost per target group is estimated to be approximately $9000. Duplicate tests per target group yielding a cost of $18,000. Testing would be done on poultry, dairy, swine, cattle and slaughter facilities, therefore the total cost of these tests are between $90,000 and $100,000.

III. Testing results will be completed within six months. Assuming favorable results, RRI plans to market as follows:

a. Contact various County, State and Federal agencies that concentrate on animal waste problems.
b. Contact various trade associations to gain support.
c. Educate producers as to the problems of waste and solution.

SUPPORT

SUMMARY

It is the intention of Recoverable Resources to solve the animal waste problem. But to do this takes time and capital. The speed at which we move this project forward depends on the following:

1. Working Capital – Recoverable Resources is willing to invest in this future but State, Federal or Trade Association Funds could speed up the process and allow us to do more studies in different geographical areas and on different species.

2. Time – This is on variable none of us can change. We can manage many trials simultaneously with adequate manpower and support. By managing multiple trials, we can then speed up the process.

3. Education – Support from academia, government and trade associations will be of paramount importance. Unless we educate the producer as to the problem and the solution, all that we have done is for nothing. A perfect example is the following quote taken from an article in the Kansas City Star dated January 10, 1998. "The problem is, it all costs money," said Clay County hog farmer Harley Bogue. "No one is willing to assist the producers." He goes on to say "The odor problem is one the media has perceived and created because of the press they can create with it. The smell has always been there, but now its suddenly a focus. It used to be that everybody had bomb shelters. That was a scare tactic. Now, it's the environment."

If we successfully do all above than we will be successful.