Approved: 2-3-98
Date

MINUTES OF THE SENATE COMMITTEE ON ENERGY AND NATURAL RESOURCES.

The meeting was called to order by Chairperson David Corbin at 8:00 a.m. on January 28, 1998 in Room 254-E of the Capitol.

All members were present except:

Committee staff present: Raney Gilliland, Legislative Research Department
Mary Ann Torrence, Revisor of Statutes
Lila McClaflin, Committee Secretary

Conferees appearing before the committee :
Steven Graham, Assistant to the Dean, College of Agriculture, Kansas State University, (KSU)
Dr. Lakshmi Reddi, Associate Professor, Civil Engineering Department, KSU
Dr. Pat Murphy, Professor, Department of Biological and Agricultural Engineering, KSU
Dr. Chuck Rice, Associate Professor, Agronomy Department, (KSU)

Others attending: See attached list

Chairperson David Corbin called for approval of the minutes of January 27. Senator Biggs with a second by Senator Tyson moved to approve the minutes of January 27. The motion carried.

Chairperson Corbin welcomed the participants from Kansas State University, and called on Steven Graham for their briefing on the Review of Lagoon Study.

Steven Graham, Assistant to the Dean, College of Agriculture, KSU, gave the introduction. He said their research was conducted over the past year by K-State Research and Extension to evaluate the effectiveness of lagoons for waste containment. The purpose of the study was to provide state agencies, and all citizens of Kansas the best science-based information possible. Data presented here cannot be used to determine or imply if Kansas lagoons are affecting groundwater quality. Given the diverse nature of lagoon systems, soil types, and geology in Kansas, a long-term, comprehensive, research program will be required to reach sound conclusions on this issue. He introduced Dr. Lakshmi Reddi, Dr. Pat Murphy, and Dr. Chuck Rice.

Dr. Lakshmi Reddi reviewed the laboratory investigations sections of the handout. He said the short-term objectives are to evaluate suitability of Kansas soils as lagoon liner materials, and to determine seepage quantities/qualities using sample-scale experiments. The long term objectives is to evaluate the effect of variability in soils and waste streams; to forecast field performance of liners based on laboratory observations; to evaluate the impact of leachate quality on groundwater resources; and recommend liner construction protocols, alternative liner materials and designs. Included in the handout are charts and graphs of the seepage rate and seepage rate vs. permeability.

Dr. Pat Murphy reviewed the sections on research thrusts and priorities. Dr. Murphy said they are striving to reach their objectives through on site research, laboratory analysis of Kansas soil and testing well water quality near animal waste lagoons. Their objectives are to: develop technology to accurately measure whole-lagoon seepage rates; measure seepage rates (inches per day) from several existing wastewater lagoons in SW Kansas; evaluate relationships between the observed seepage rates and lagoon construction methods; and to test computer models of lagoon evaporation to improve and simplify the measurement of lagoon seepage.

Dr Chuck Rice discussed the Kansas Groundwater Quality Monitoring Network and distributed maps showing geographic distribution of sites and groundwater regions, and another map showing the nitrate concentrations in the state. The information was from the 1993 annual report of KDHE Groundwater Quality Monitoring Network

The last page of the handout has a lagoon research timeline projection for April 1998, July 1998, January 1999 and October 1999 (Attachment 1)

They responded to questions. Steven Graham closed by saying in 1998 they would continue to do research on the permeability test on Kansas soils, and measure seepage rates in the field. They have requested more funding from the Governor to continue research, and they have a scheduled setup for January 1999 and October 1999.

The meeting adjourned at 9:00 a.m.

The next meeting is scheduled for January 29, 1998

.

SENATE ENERGY & NATURAL RESOURCES COMMITTEE GUEST LIST

DATE: 1-28-98

NAME	REPRESENTING
LAKSHMI REDDI	Kansas State University
PAT MURPHY	" " "
Chuck Rice	" " "
Steven Graham	" " "
Connie Fischer	KS Dept. Commerce & Housing
Erika L. Ungeheuer	Self.
Sharon Falk	GMD #5 Stafford, Ks
Larrie Ann Brown	KS Govt Consult.
Mike Jensen	Ks Pork Council
Jim Allen	Seaboard
Larry Kleeman	League of KS Municipalities
Woody Moses	Ks. Assn Ag. Ind. Assn
Charles Benjamin	KNRC/KS Sierra Club
Leslie Kaufman	Ks Farm Bureau

KSTATE
Kansas State University

BRIEFING TO THE ENERGY AND NATURAL RESOURCES COMMITTEE
KANSAS SENATE

28 January, 1998

Evaluation of Lagoons for Containment of Animal Waste

Participating from Kansas State University:

Steven Graham, Assistant to the Dean, College of Agriculture
Dr. Pat Murphy, Professor, Department of Biological and Agricultural Engineering
Dr. Lakshmi Reddi, Associate Professor, Civil Engineering Department
Dr. Chuck Rice, Associate Professor, Agronomy Department

Kansas Center for Agricultural Resources and the Environment
K-State Research and Extension
Kansas State University
(785) 532-7103 <kcare@ksu.edu>

KCARE

Senate Energy & Natural Resources
Attachment: 1
Date: 1-28-98 1-1

Introduction

This brief report contains results from research conducted over the past year by K-State Research and Extension to evaluate the effectiveness of lagoons for waste containment. Our overall purpose for doing this work is to provide to producers, state agencies, and all citizens of Kansas the best science-based information that we possibly can regarding the effectiveness of lagoons to contain waste. As a public-supported institution, dedicated to research and information dissemination, our intent is to be both responsive to the research and information needs of the citizens of Kansas and responsible as scientists to disseminate scientifically valid results.

Several important points should be made regarding the objectives of our study and this report:

1) One of the objectives of this work is to evaluate the efficacy of different soil materials as liners for lagoons. We present here our results from laboratory evaluation of the characteristics of different soil materials with respect to their suitability as lagoon liners.

2) A second objective of our work is to measure the seepage rate for several functioning lagoons. Our field results for measurement of the seepage rate of whole lagoons is still very preliminary. We have studied only one lagoon over a relatively short period of time. Scientifically valid studies must be replicated before the results are generalizable, and a sufficiently large number of cases and conditions must be studied in order to have a complete understanding of natural phenomena. We plan to evaluate several more lagoons in the coming year

3) We are aware that a burning question is, "What are the amounts and fate of chemicals and/or microorganisms leaving lagoons?" Although our study was not designed originally to answer that question, we did conduct a review of KDHE data on water quality from well surveys. We provide a summary of that review here. Although the data base is still small, no evidence of contamination by animal waste lagoons was found.

Although our review of KDHE well data provides no direct evidence of contamination of groundwater by animal waste lagoons, gaining a complete understanding of the functioning of lagoons and the fate of chemicals leaving lagoons is a long-term venture. This is due to the complexity of these systems and of transport phenomena. With funding proposed in the Governor's budget, we plan to expand our efforts in addressing these issues, and to initiate additional research to evaluate the amounts and fate of chemicals and microorganisms leaving lagoons. We will continue to keep producers, decision and policy makers, and the public informed of the results of this and any future work in this critical area of inquiry.

Executive Summary from Report Delivered to KDHE - 12 Nov., 1997

Animal wastes often are collected in large lagoons in an effort to separate the liquid from solid phase and to reduce the quantity of solids through a digestion process. Questions recently have arisen concerning whether these lagoons adequately protect drinking water supplies from contamination by phosphorus, nitrogen, organic carbon, and bacteria. This study was executed to address these issues.

The soil materials and compaction criteria used to prepare lagoon liners in the field were studied in a Civil Engineering laboratory to determine if design recommendations are adequate to meet the current 0.25 inch/day standard. Three soils from western Kansas that are typically used in lagoon liners were tested, including a very sandy soil amended with 6% bentonite clay. Given a compacted soil liner 3 ft thick and a water depth of 20 ft, the calculated leaching rates ranged from 0.0013 to 0.13 inch/day. The majority of soils tested produced a leaching rate less than 0.0075"/day. The addition of bentonite to a sandy soil at the relatively low rate of 6% by weight had minimal impact on seepage rate. This aspect of the laboratory study suggests that the recommended procedures for liner preparation are adequate to meet the maximum leaching standard currently used by Kansas Department of Health and Environment.

The quantity of leachate is only one environmentally relevant measurement for lagoons; the quality of the effluent also is important. Therefore, the laboratory study was extended to analyze leachates for nitrate, ammonia, phosphorus, and bacteria when a suspension from a swine lagoon was used as the influent. Nitrate concentrations were very small (<2 mg/L) for the entire experiment. Ammonia concentrations continued to rise during the leaching, approaching the concentrations found in the influent waste suspension. Dissolved phosphorus was undetectable during the first few days of leaching, but approached 2 mg/L with time. Bacterial counts were consistently near 10^8 colony forming units/mL for the entire experiment (species of bacteria were not determined). From the laboratory study, we conclude that recommended construction parameters will achieve the desired 0.25 inch/day leaching rate, but the liner has a minimal impact on the composition of the water that passes through it. The potential impact of lagoon leachates on groundwater quality will depend upon site specific parameters, such as the chemical and physical properties of the soil and the depth to the water table.

A field study was designed to measure leaching rates under typical environments. Instrumentation was developed to measure simultaneously the evaporation, seepage, and total change in depth from two lagoons. Measurements were obtained using custom-designed floating platforms that were tethered in the lagoons being studied. Each platform measured evaporation using a floating lysimeter and the Bowen ratio energy balance technique. The water levels in the lagoons and the lysimeters were continuously monitored with ultrasonic ranging transducers. The equipment was deployed on a cattle feedlot in October, 1997 to test and refine the instrumentation. The lagoon under study, constructed in the late 1970s from native clay loam soils, was approximately 3 ha with an average water depth of 1.2 m. The new measurement system measured seepage to within 0.2 mm/day (0.0078"/day) after only a few days of operation (providing weather conditions are adequate). Seepage from the test lagoon was 2.38 mm/day (0.09"/day), which was below the suggested design standard of 0.25"/day. Average evaporation was 2.46 mm/day, and the change in depth was 4.84 mm/day. Although the data are preliminary, seepage from an older established facility was still within design standards after many years of use and varied management (i.e., cleaning, drying, etc.). Equipment developed for the field study will be used for future research on swine, cattle, and dairy lagoons. Data will help determine relationships between lagoon construction protocols, site management, and actual seepage rates.

Kansas Department of Health and Environment records were used to document concentrations of nitrate in wells across the state, with particular attention to wells in the vicinity of lagoons. Very high nitrate concentrations in groundwater have been recorded in two instances near beef packing plants. Although the nitrate contamination plumes included the region beneath the waste lagoons, it was impossible to determine the exact source of the contamination. In a small survey of lagoons associated with beef feedlots, nitrate concentrations in groundwater were not impacted by the presence of lagoons. Although some dissolved constituents from the waste (chloride and calcium) migrated from the lagoon to the groundwater, the liner was able to attenuate the nitrates, probably through denitrification.

Data presented here cannot be used to determine or imply if Kansas lagoons are affecting groundwater quality. Conclusions on the fate and transport of lagoon effluent must include research on physical filtration, chemical transformations, and microbial decomposition, processes that often help purify water as it moves through the soil. These factors, in combination with subsurface hydrology, ultimately determine the chemical nature of the soil solution under the lagoon. Additional research is planned to study the concentrations of nutrients in the soil profile within and under lagoon liners. These data will be analyzed in combination with laboratory studies and measured seepage rates to better understand the relationship between lagoon construction protocols and nearby groundwater quality. Given the diverse nature of lagoon systems, soil types, and geology in Kansas, a long-term, comprehensive, research program will be required to reach sound conclusions on this issue.

Laboratory Investigations

Objectives

Short-term (1st year):

Are current KDHE regulations of 0.25 inch/day met?

- Evaluate suitability of Kansas soils as lagoon liner materials
- Determine seepage quantities/qualities using sample-scale experiments

Long-term:

Can the KDHE regulations and liner construction standards adequately protect groundwater resources?

- Evaluate the effect of variability in soils and waste streams on lagoon liner performance
- Forecast field performance of liners based on laboratory observations
- Evaluate the impact of leachate quality on groundwater resources
- Recommend liner construction protocols, alternative liner materials and designs

Laboratory Investigations (Contd.)

Experimental Methods (Short-Term Studies)

- Three different types of soils from Southwest Kansas were acquired and were tested for their physical properties to assess how they fit in the USDA grouping.

- The soils were compacted (one of the three was amended with bentonite) in steel columns in accordance with engineering standards and seepage experiments were conducted under representative field conditions.

- The seepage from the soil columns was analyzed for Nitrate, Phosphorous, and Ammonia concentrations, and microbial counts.

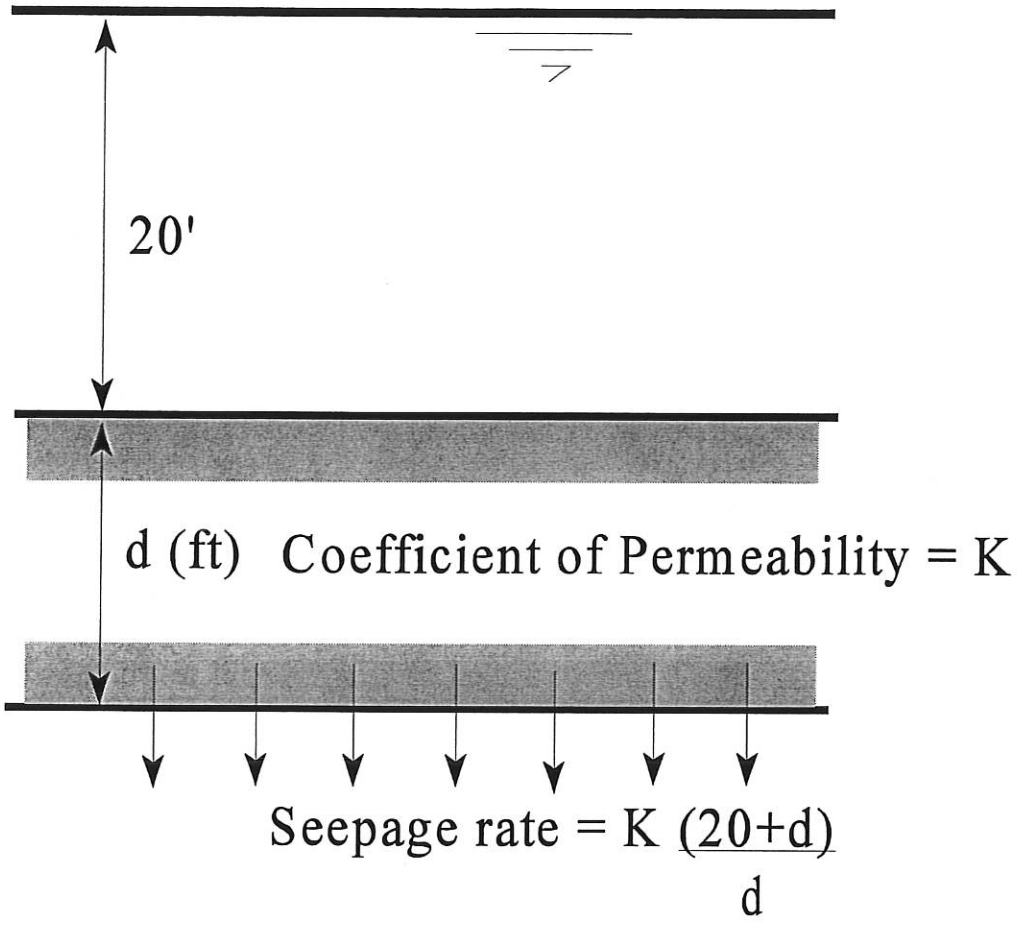


FIGURE 4.

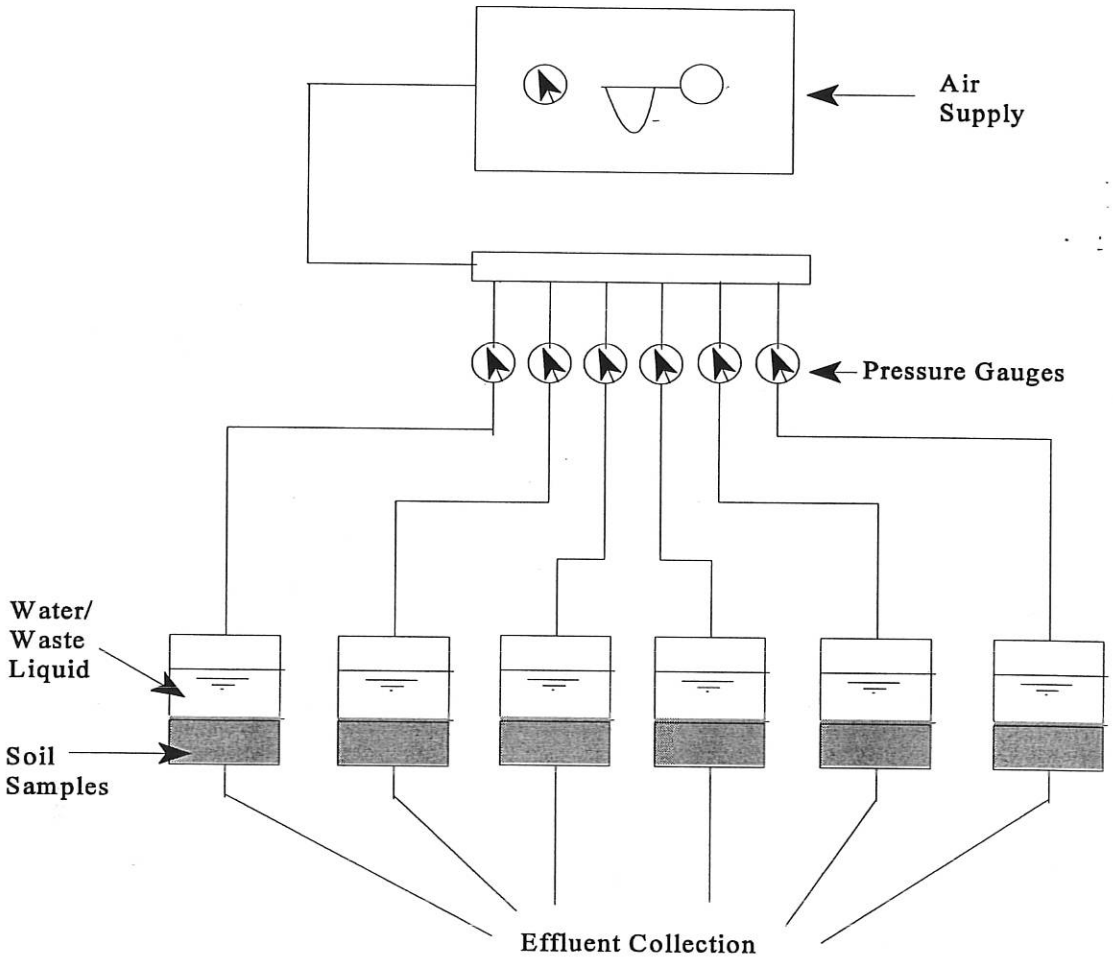

Air
Supply
Pressure Gauges
Water/
Waste
Liquid
Soil
Samples
Effluent Collection

FIGURE 3.

Laboratory Investigations (Contd.)

Preliminary Results (Short-Term Studies)

- For the soils examined and for one type of animal waste studied, it was found that the KDHE regulation of 0.25 inch/day could be met if standard field construction practices are followed. The calculations assume that the lagoons are filled with animal waste to a maximum height of 20 feet and the thickness of the liner ranges from 1 to 3 feet.

- It is possible to use coarse soils of Southwest Kansas as liner materials provided they are amended with about 6% bentonite.

- Soils available in Kansas generally belonged to USDA Groups II, III, and IV.

- For the animal waste studied, chemical analyses on seepage indicated presence of Ammonia in high concentrations.

Seepage Rate vs. Permeability for Depths 1', 2', & 3'

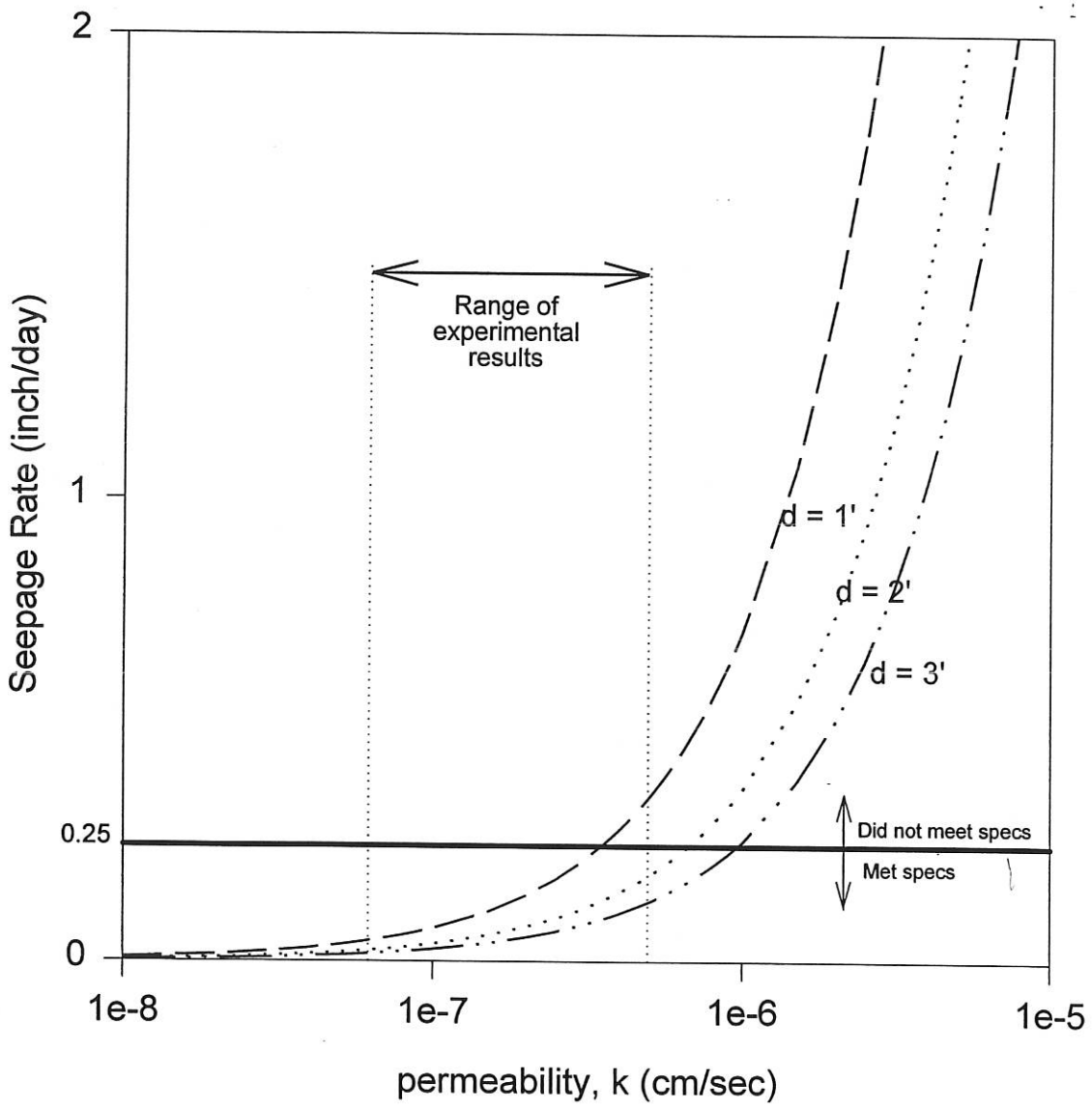


FIGURE 5.

Laboratory Investigations (Contd.)

Ongoing Studies

- Continue experiments to look at the effects of soil and waste variability on seepage quantities and qualities.
- Assess the long-term qualities of seepage from soil columns.
- Use laboratory data to forecast field performance of either existing or new lagoon liners.
- Assess the impact of seepage quantities and qualities on groundwater resources and answer the ultimate question: *Can the KDHE regulations and liner construction standards adequately protect groundwater resources?*
- Provide recommendations to the KDHE on liner material selection, designs, and construction standards.

Main Objectives

Short Term

√ Determine if lagoons built and managed under existing guidelines will keep seepage rates below the recommended level of 0.25"/day.

- Construction/Engineering
- Soil Properties/Self-sealing
- Site History (management, species)

Long-term

√ Quantify Relationships between Seepage rates and groundwater quality

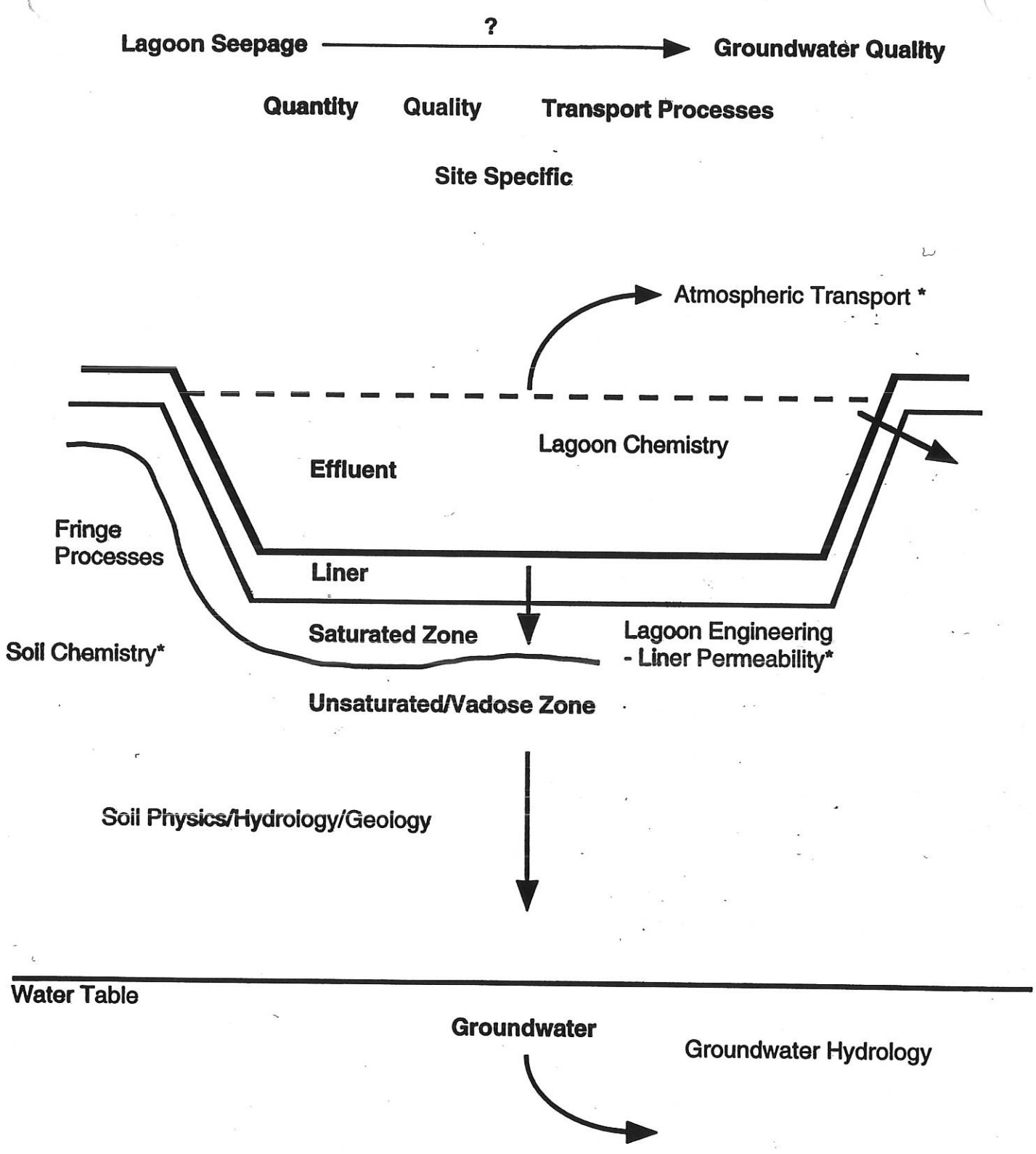
- Geology/Hydrology
- Soil Chemistry/ Microbiology
- Site History (Species)

Research Thrusts and Priorities

√ **Field Research**
Experimentation on existing and new lagoons

√ **Laboratory Analysis**
Permeability of Kansas soils

√ **Water Survey**
Well-water quality near animal waste lagoons


Lagoon Seepage
?
Groundwater Quality
Quantity
Quality
Transport Processes
Site Specific
Atmospheric Transport *
Lagoon Chemistry
Effluent
Fringe Processes
Liner
Saturated Zone
Lagoon Engineering - Liner Permeability*
Soil Chemistry*
Unsaturated/Vadose Zone
Soil Physics/Hydrology/Geology
Water Table
Groundwater
Groundwater Hydrology

Objectives

Develop technology to accurately measure whole-lagoon seepage rates

Measure seepage rates (inches per day) from several existing wastewater lagoons in SW Kansas

Evaluate relationships between the observed seepage rates and lagoon construction methods

Test computer models of lagoon evaporation to improve and simplify the measurement of lagoon seepage

I-15

Methods

Water Balance Approach (conservation of mass)

Detailed measurements of inflow, outflow, and the change in storage will allow the determination of seepage

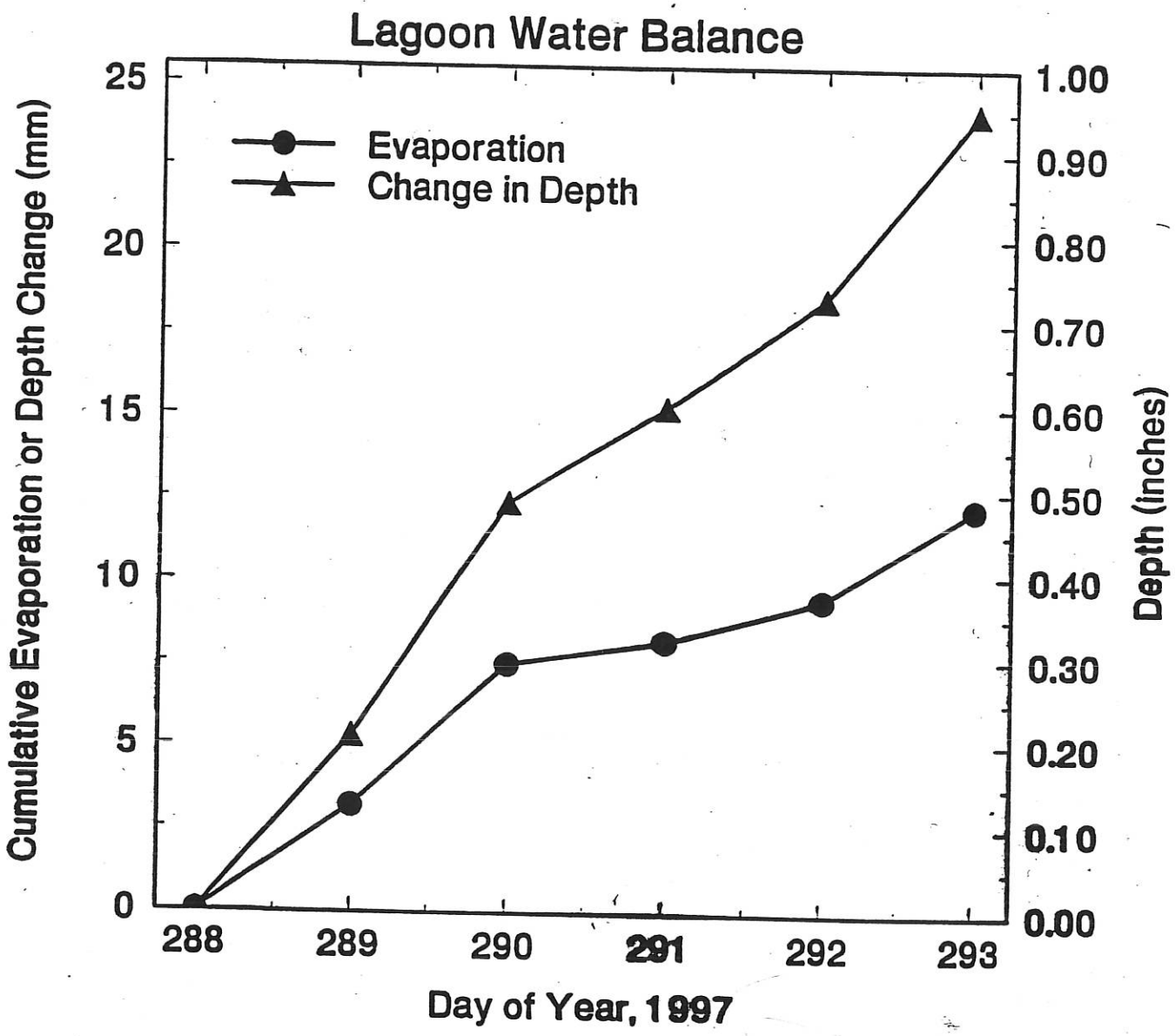


Figure 3. Cumulative evaporation and change in water level over a 5-day period at the test lagoon. Data were recorded by ultrasonic ranging transducers positioned over the lagoon and a floating lysimeter.

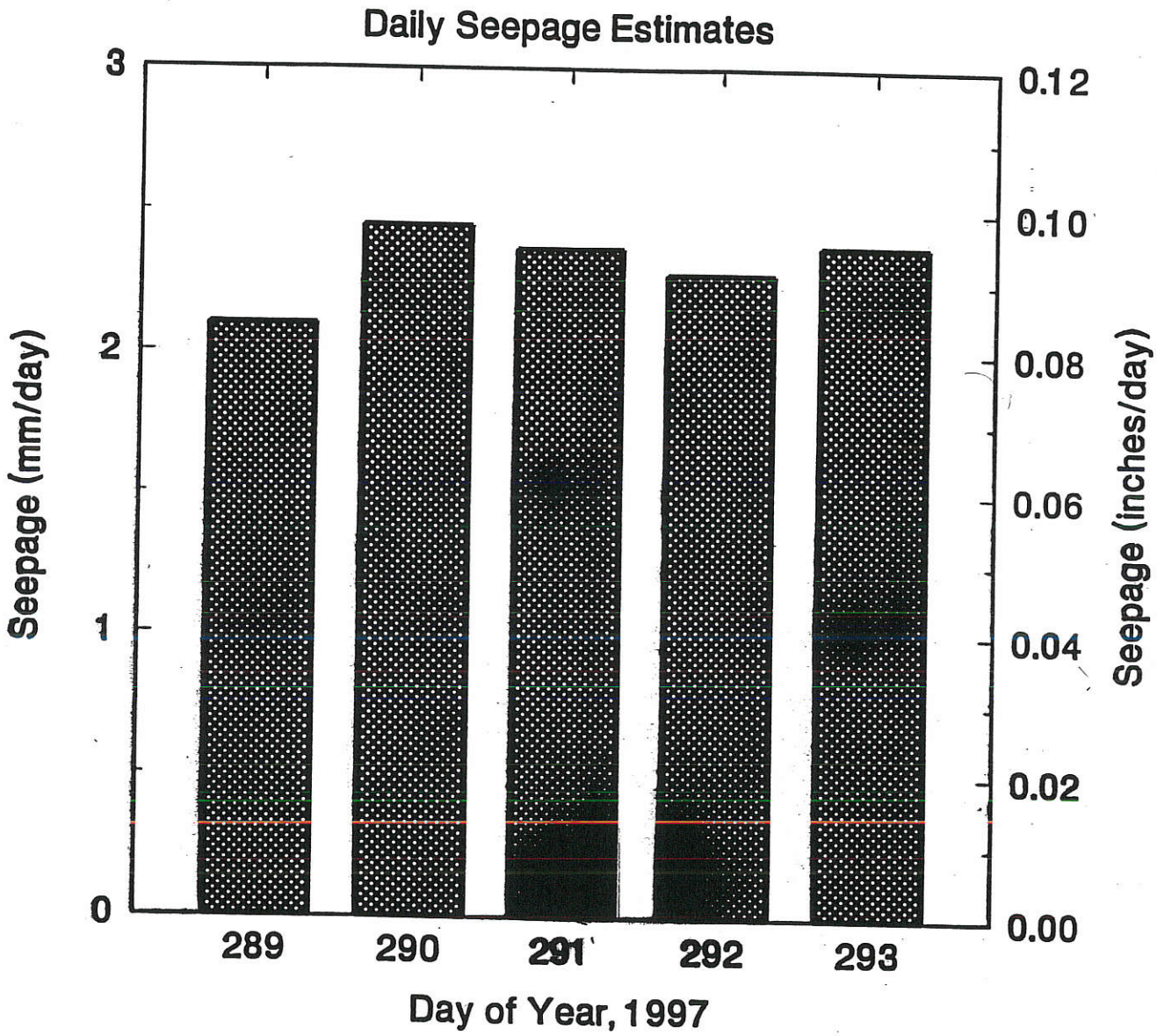


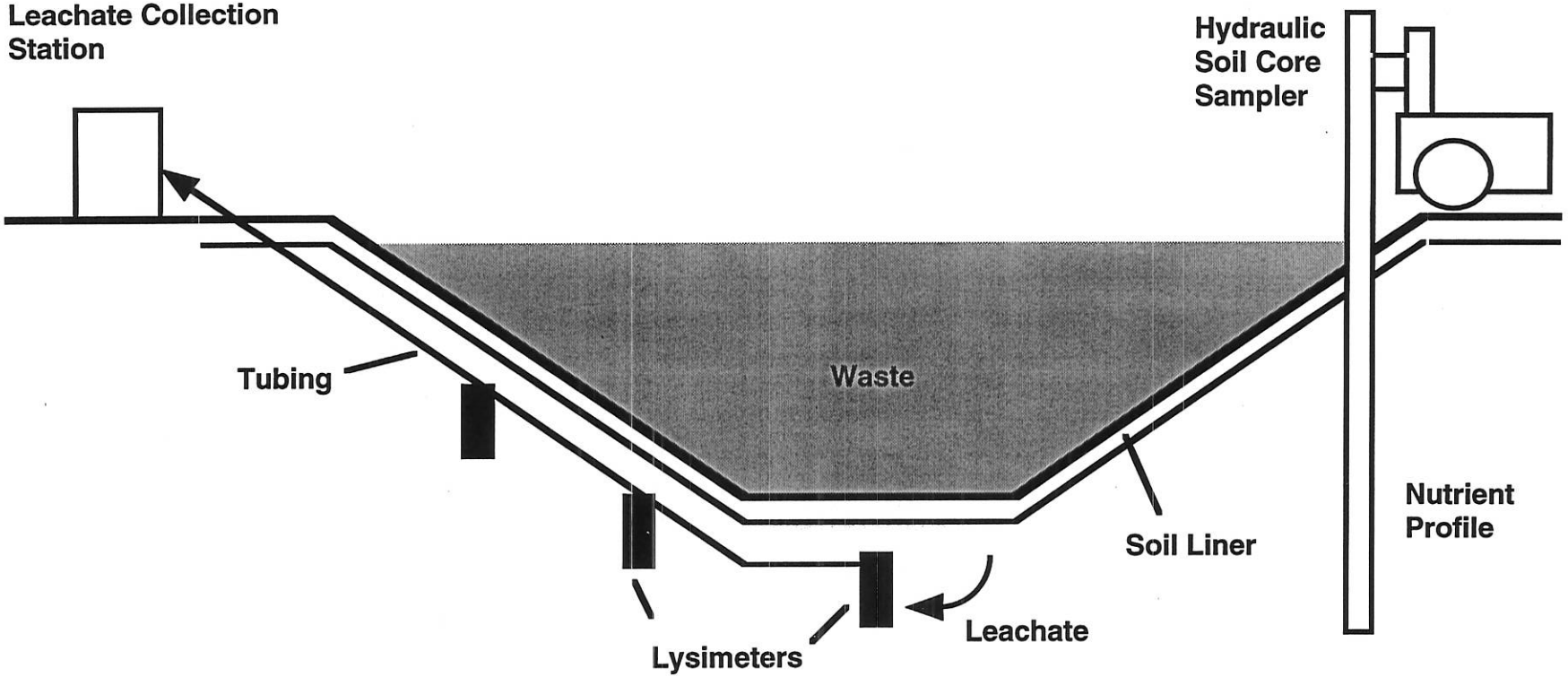
Figure 4. Daily seepage measurements from the lagoon over a 5-day period as determined from evaporation and water level measurements (see Fig. 3).

New Research Opportunities

Installation of suction lysimeters beneath a new swine lagoon

Soil cores from 20-year old swine lagoon

61-19


Leachate Collection Station
Hydraulic Soil Core Sampler
Tubing
Waste
Soil Liner
Nutrient Profile
Lysimeters
Leachate

1-20

KDHE Groundwater Quality Monitoring Network

Data collected reported for 1991-1995

250 wells sampled (~125 wells sampled per year some more than once per year)

- 71% Public water supply wells
- 14% Irrigation wells
- 10% Rural domestic water supply wells
- 1% Livestock watering wells
- 1% Industrial wells
- 3% Multiple use wells

681 samples for 1991-1995

- State-wide
  12% of wells > 10 mg NO_3^--N/L
  Range 0-65 mg NO_3^--N/L
- Region 7 (North Central Kansas) had the highest percentage of wells exceeding the Maximum Concentration Load (MCL); 20-30%

- Percentage of wells exceeding the MCL has not changed since 1976.
- Contaminated wells predominately in areas with sandy soils and shallow water tables.

Documentation of wells located near livestock waste lagoon facilities

Hobson (1991) published a M.S. Thesis to examine livestock operations on groundwater contamination.

Four feed yard lagoon sites were selected with shallow depths to groundwater (4 to 12 feet below bottom of the lagoon).

Down-gradient wells contained less NO_3^- than the up-gradient wells.
11 to 14 mg NO_3^--N/L compared to 14 -17 mg NO_3^--N/L.

The conclusion was that the lagoons was not a source of NO_3^- contamination in the shallow groundwater.

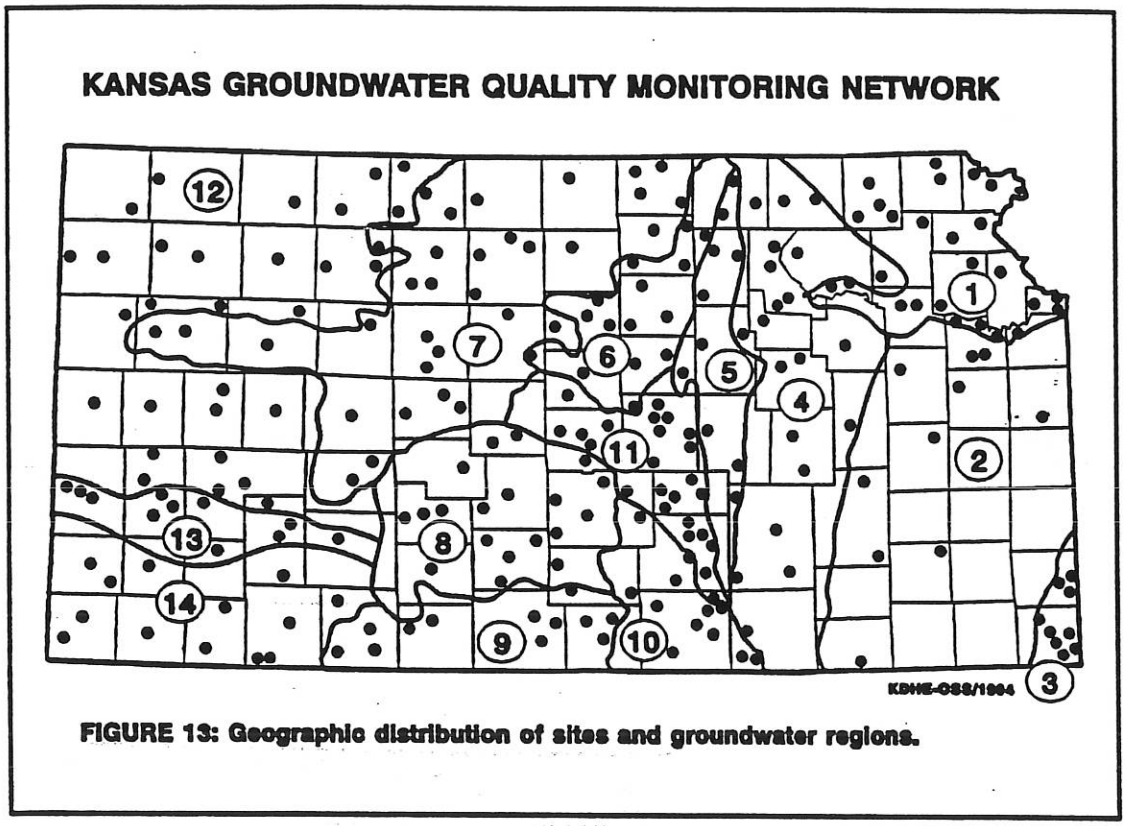
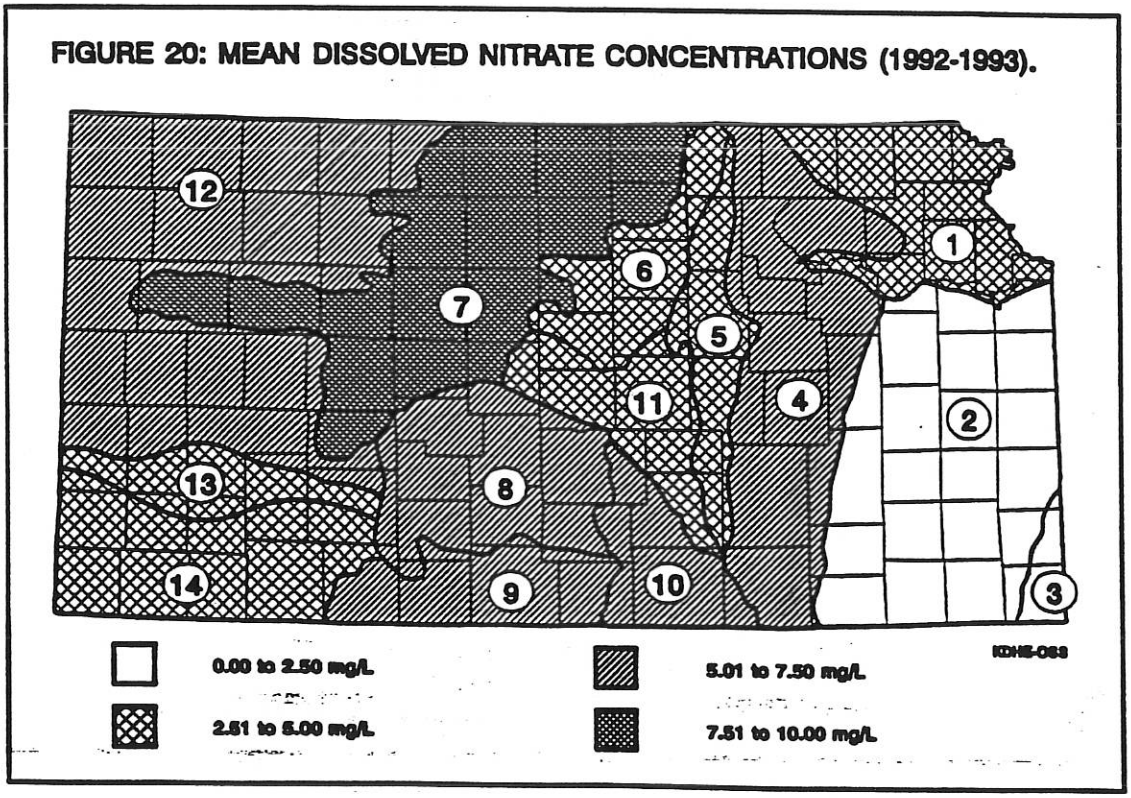


FIGURE 13: Geographic distribution of sites and groundwater regions.



LAGOON RESEARCH TIMELINE

April 1998	July 1998	January 1999	October 1999
Laboratory permeability test results of Kansas soils due to KDHE.	Progress report of seepage rates of field scale lagoon liners.	Long-term seepage rate determinations and resulting water quality changes of liquid passing through soil liners -laboratory and lagoon results.	Evaluation of the impact of lagoon liner seepage on groundwater quality using hypothetical simulations.
Comprehensive review of previous research on seepage from animal waste lagoons; Measure seepage rates from 2 swine waste lagoons and 2 cattle feedlot runoff lagoons in western Kansas; Development and verification of technology for measuring whole-lagoon seepage; Preliminary analysis of lagoon chemistry; Installation of suction lysimeters beneath a new swine waste lagoon	Measured seepage rates from 2 more lagoons (possible inclusion of dairy). Additional lagoon chemistry survey information.	Continue work on whole lagoon seepage. Our goal is to have seepage data from 12 to 15 lagoons at this time (e.g., 6 Swine, 6 cattle feedlot, 2 dairy). Data will include estimates of nutrient flux (g nitrogen lost via seepage per year) for each lagoon. This information is needed to accurately predict how lagoon effluent may impact groundwater quality. Lagoon chemistry: Differences between species will be documented. Seasonal patterns in lagoon chemistry will also be available. Preliminary plan or analysis of soil core data from a 20-year old swine waste lagoon. Coring of lagoons would yield information on the depth to which seepage has traveled and information on the structure of the soil liner. Coring coupled with previous seepage information and history of the lagoon would give a rate of downward movement of the seepage front. Soil analysis of the cores may give an indication of the chemicals present in the seepage. It make take some time for the lagoon to dry. Thus, it is difficulty to estimate when samples can be retrieved from the zone beneath the lagoon.	
Complete analysis of KDHE well data; Chemical and biological analyses of leachate from laboratory studies.			Complete chemical and biological analyses of samples; Analyses of the liquid and soil samples.