Approved: January 25, 2000
Date

MINUTES OF THE HOUSE COMMITTEE ON AGRICULTURE.

The Committee met jointly with the House Environment and Senate Natural Resources Committees and was called to order by Joann Freeborn, Chairman of the House Environment Committee, at 3:30 p.m. on January 10, 2000, in Room 313-S of the Capitol.

All members were present except: Representative Feuerborn - excused
Representative O'Brien - absent

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

Conferees appearing before the committee:
Dr. Bill Hargrove, Director, Kansas Center for Ag Resources and the Environment, Kansas State University

Others attending: See attached list

Dr. Bill Hargrove, Director, Kansas Center for Ag Resources and the Environment, Kansas State University, reviewed confined animal lagoon research being conducted by Kansas State University. He presented slides and explained the latest results of Dr. Jay Ham's *Field Evaluation of Animal-Waste Lagoons: Seepage Rates and Ground Water Quality*. Research topics included: waste chemistry and biology, lagoon seepage rates, subsurface nitrogen movement, potential impact on ground water quality, and improved construction and management. Dr. Hargrove reported that to date their research has found that seepage rates are low, averaging 0.047 inches per day, far less than the 0.25 inch per day standard. They have found that some nitrogen does move into the subsoil; however, in many cases much of this nitrogen remains close to the lagoon. He said there is the possibility that this storehouse of nitrogen under the lagoon could become mobile and move toward the groundwater when the lagoon is emptied and dried.

Dr. Hargrove reported that their research shows the potential impact of lagoons is very site specific and species specific. He explained that soil properties and water table depth at the proposed construction site are combined with data on species and waste management plans to calculate a maximum allowable seepage rate. He said that earthen-lined lagoons can probably be used safely at many locations; however, plastic-lined lagoons may be needed in certain areas. Dr. Hargrove said design tools need to be developed that regulators can use to customize lagoon requirements for each permit, that the key to any successful approach will be to design a system that gives engineers and producers the flexibility to explore many possible approaches to lagoon design. (Attachment 1)

The meeting adjourned at 4:30 p.m. The next meeting is scheduled for January 12, 2000.

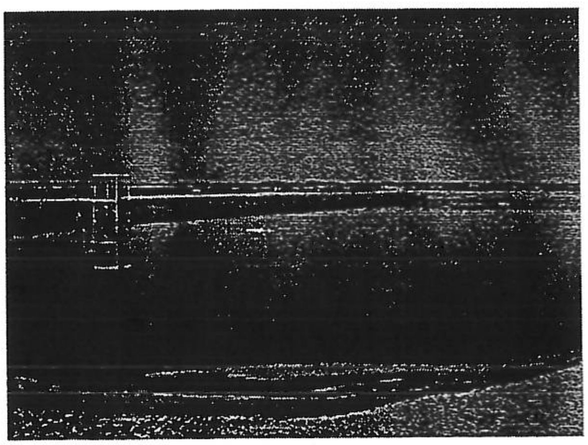
HOUSE AGRICULTURE COMMITTEE GUEST LIST

DATE: January 10, 1999

NAME	REPRESENTING
Jim Allen	Sea board
Karl Mueldener	KDHE
Greg Foley	KDHE
Amy Metzinger	Showalter Intern
Dale Lambley	KDA
Garry Keeler	KDA
SUE PETERSON	K-State
Ron M. Ryan	Farmer-Rancher
Gary Hayzlett	Legislator
Helen Hayzlett	
Nina Atencio	Bottenberg & Assoc.
John C. Bottenberg	KPPC
Del Shirley	Governor's Office
Doug Wareham	KGFA/KFCA
Kerri Ebert	KS Dairy Association
Ron Klataske	Audubon of Kansas

Field Evaluation of Animal-Waste Lagoons:
Seepage Rates and Ground Water Quality

Jay M. Ham
Associate Professor
Department of Agronomy
Kansas State University



Questions ?

- Are lagoons in Kansas being built and used in a manner that adequately protects ground water quality ?
- What are the best ways to site, construct, and manage a lagoon to reduce the risk of ground water contamination ?

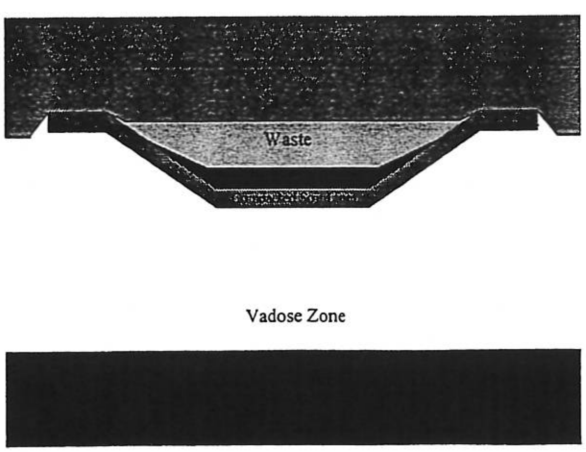
House Agriculture Committee
January 10, 2000
Attachment 1

K-State Research Topics

- Waste Chemistry and Biology
- Lagoon Seepage Rates
- Subsurface Nitrogen Movement
- Potential Impact on Ground Water Quality (Risk Analysis)
- Improved Construction and Management
-

Waste Lagoons and Ground Water Quality

- Toxicity
- Input Loading
- Aquifer Vulnerability



Methods

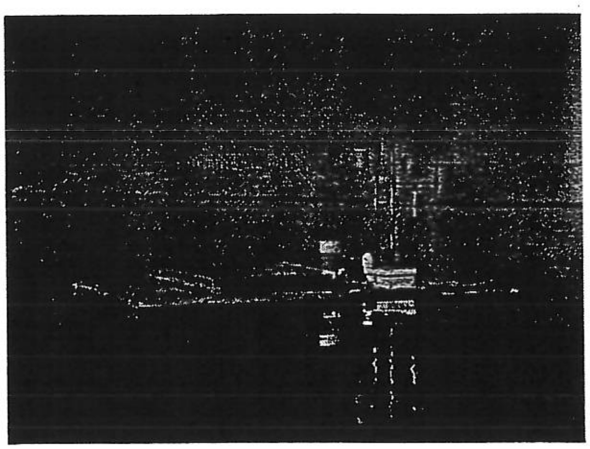
- Waste Chemistry Survey
- Whole-Lagoon Water Balance

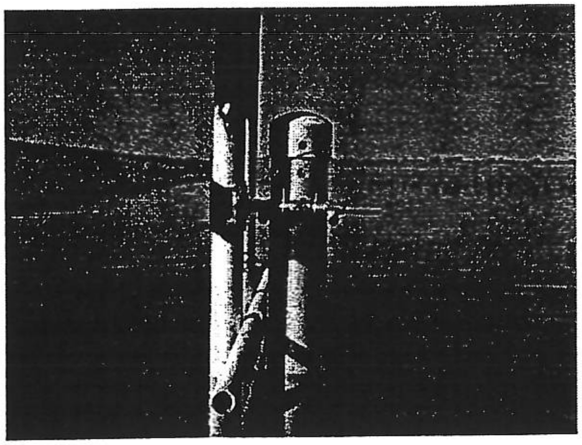
  Seepage = Change in Depth - Evaporation

- Soil Coring Beneath Existing Lagoons
- Lab Analysis and Computer Modeling

Chemistry of Lagoon Waste

Parameter (ppm)	Swine Lagoon	Cattle Feedlot Runoff Lagoon
Nitrate	1	1.5
Ammonium	673	98
Sodium	270	148
Choride	276	569
Phosphorus	43	48



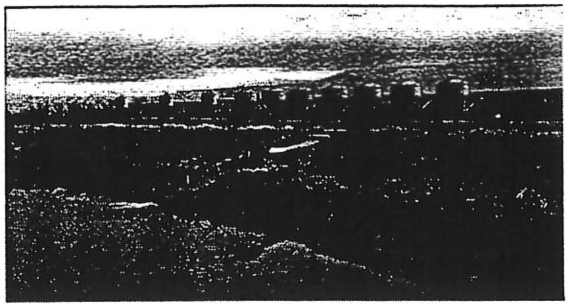


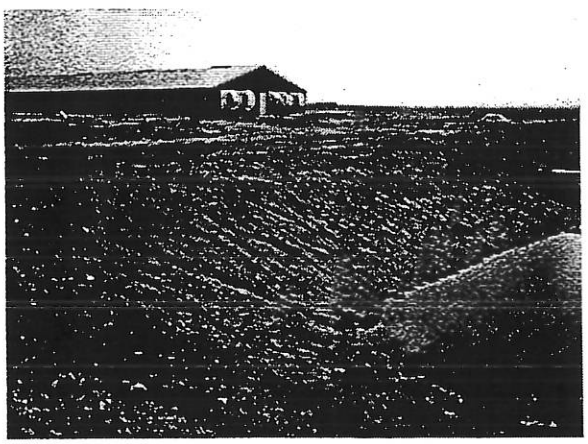
Seepage Losses From Waste Lagoons

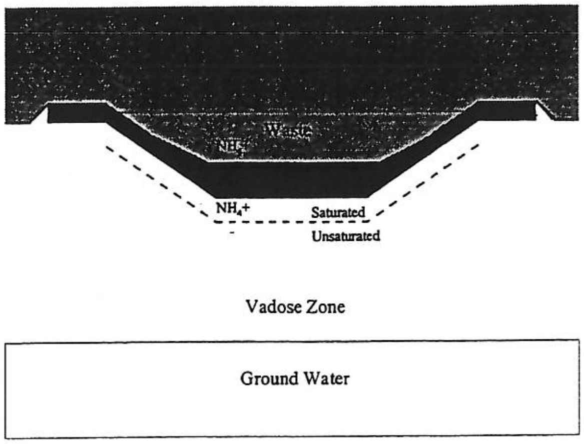
Lagoon	Seepage Rate (inches/day)
swine	0.06
swine	0.08
swine	0.03
swine	0.03
swine	0.06
swine	0.05
swine	0.02
cattle	0.01
cattle	0.09

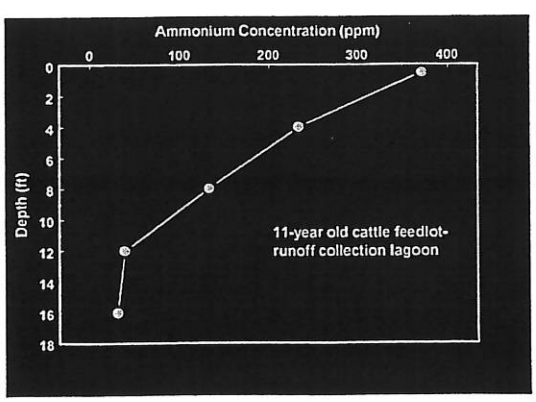
Lagoon Seepage, Kansas and Iowa

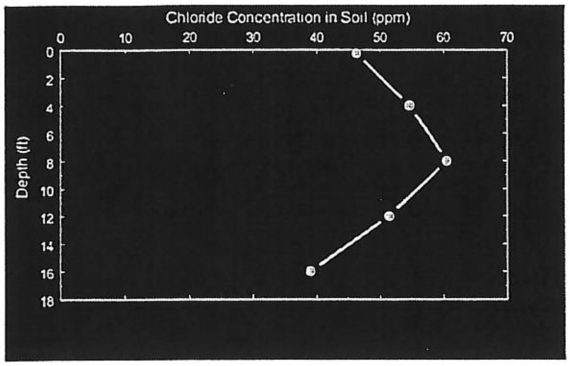
State	n	Avg.	Range
		------ mm/d ------	
Kansas	10	1.2	0.2-2.3
Iowa	27	1.2	0.1-2.4

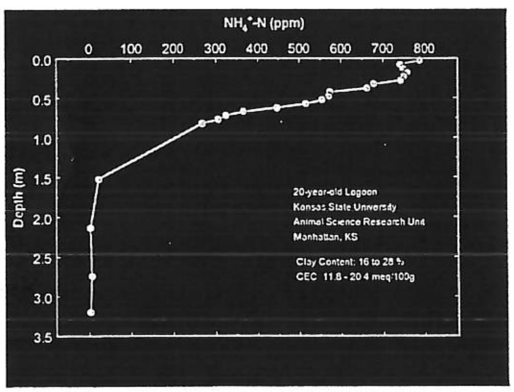




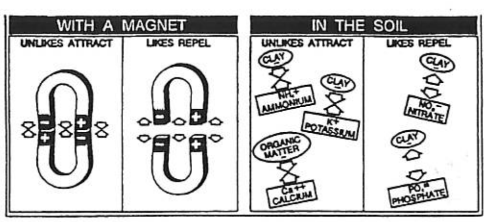

Waste
NH4+
Saturated
Unsaturated
Vadose Zone
Ground Water

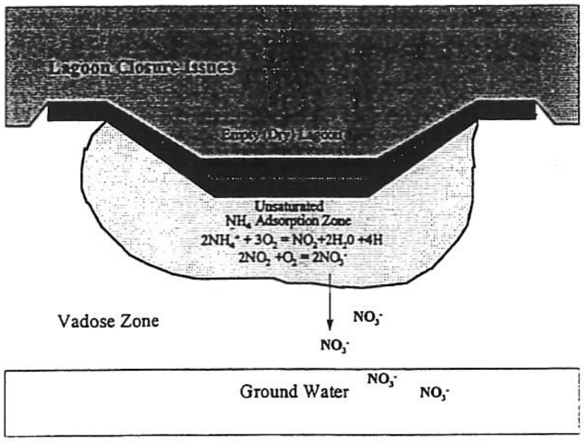

Ammonium Concentration (ppm)
0
100
200
300
400
0
2
4
6
8
10
12
14
16
18
Depth (ft)
11-year old cattle feedlot-runoff collection lagoon





Soil Cation Exchange





Summary

- Seepage rates are low (<0.1 inch per day)
- Sludge does reduce permeability of liner
- Some nitrogen does move into the subsoil
- In many cases, much of this nitrogen will remain close to the lagoon
- The storehouse of nitrogen under the lagoon could become mobile and move toward the groundwater when the lagoon is emptied and dried (closure)

ANIMAL WASTE MANAGEMENT AND UTILIZATION
UPDATED PLAN OF WORK
K-STATE RESEARCH AND EXTENSION
October, 1999

Introduction

We have about eight months remaining in our 3-yr contract with the Kansas Water Office, and about 20 months of funding from special state appropriations from HB2950. Recently, the Governor's Office and KDHE have requested a focus on the Equus Beds Region of the state for the coming months. We have analyzed our current commitments and workload and propose to make the following adjustments to our Plan of Work in order to respond to the Governor's and KDHE's request.

Animal Waste Lagoons and Water Quality

Liner Construction - Dr. Lakshmi Reddi, Department of Civil Engineering
We plan to develop site-specific configurations for liners and to evaluate chemical sealants, geomembranes, and geo-composite liners. Details of this work are presented in Attachment A, "General and Region-Specific Recommendations for Siting, Construction, and Operation of Animal Waste Lagoons in the State of Kansas".

Waste Chemistry - Dr. Jay Ham, Agronomy Department
We plan to continue survey sampling of lagoons for chemical composition. We will determine the chemical composition of all lagoons that we are allowed to study in the Equus Beds Region. Methodologies are outlined in our previous report.

Seepage Rates - Dr. Jay Ham, Agronomy Department
Plans are in place to measure the seepage rate on three lagoons this year, 2 swine lagoons and 1 beef cattle feedlot lagoon. Two of these are located in the western part of the state (Finney and Mead Counties) and one is located in the east (Osage County). None are located in the Equus Beds Region. We are currently trying to locate swine producers who will cooperate with us to allow seepage rate measurements in the Equus Beds Region. We would like to study two or three swine lagoons if we can find cooperators. Methodologies are outlined in our previous report.

Coring Underneath Lagoons - Dr. Jay Ham, Agronomy Department
Plans are in place to core underneath a total of eight lagoons: 1 beef, 3 swine, 3 human, and 1 mixed. The locations are in Finney, Mead, Osage, Harvey, McPherson, and Riley Counties. Of these, one swine and three human lagoons are in the Equus Beds Region. We would like to core underneath additional swine lagoons in the Equus Beds Region if we can find cooperators. Methodologies for this work are outlined in our previous report.

Logical Framework for Lagoon Siting and Liner Requirements - Dr. Jay Ham, Agronomy Department

Dr. Ham has developed a prototype logical framework for lagoon siting and liner requirements based primarily on depth to groundwater and characteristics of the soil at the site. He will be testing and validating this framework through the chemical characterization, seepage rate, and coring work described above. A draft description of the logical framework is presented as Attachment B, "Towards Site-Specific Guidelines for Animal-Waste lagoons in Kansas".

Lagoon Closure - Dr. Jay Ham and Dr. Mary Beth Kirkham, Agronomy Department, and Kyle Mankin, Bio and Ag Engineering Department

We have initiated studies on use of vegetation to remediate lagoon sites with high concnetrations of salt and ammonium. We are screening plants for their ability to grow and absorb the excess nutrients at these sites. A description of this work is presented as Attachment C, "Initial Crop Growth in Soil Beneath Animal Waste Lagoons". We are also conducting leaching studies on soil columns (sandy soil type) collected from a swine lagoon in McPherson County. This work is described in Attachment D, "Vegetative Reclamation of Abandoned Swine Lagoons".

Land Application of Livestock Waste

Soil Sampling - Dr. Alan Schlegel, Agronomist, Southwest KS Research-Extension Center, Tribune, KS

We plan to sample about 6 sites in Harvey and Reno counties where waste has been applied for many years. Sites where livestock waste and sites where municipal waste have been applied will be sampled. We also plan to review other data from previous projects done in the area. Methodologies are presented in our previous report.

Nutrient Content of Manure - Dr. Bob Goodband, Dr. Mike Tokach, Dr. Jim Nelssen, Animal Science Department and Gary Keeler and Dale Lambley, KDA

We are conducting a review and analysis of the KS Department of Agriculture data base on nutrient content of lagoons submitted as a part of permit applications. This is to verify or change the book values that are being used for nutrient content of manure. We are also collecting additional samples from KS producers for analysis. We will also sample different waste handling systems for nutreint content to improve our data base for use in nutrient management planning. Details of this project are presented as Attachment E, "Chemical Composition of manure in Kansas Swine Lagoons".

Air Quality

Air Quality Monitoring System to Evaluate Setback Distances - Dr. Jay Ham, Agronomy Department

We plan to evaluate the setback distances required in HB2950 by establishing an air quality monitoring system at several swine production sites. A proposal for this work is presented as Attachment F, "An Air Monitoring Network for Determining Optimal Setback Distances for Concentrated Animal Operations".

Fie. .ivestigation of Seepage Losses From Animal Waste Lagoons†

Jay M. Ham, Ph.D., Department of Agronomy, Kansas State University, Manhattan, Kansas

What is an animal waste lagoon?

Anaerobic lagoons are used throughout Kansas to collect, store, and treat waste at animal feeding operations. Most lagoons are earthen basins lined with 12 to 18 inches of compacted soil or clay to limit seepage losses. At cattle feedlots and dairies, wastewater entering a lagoon is runoff from precipitation that has fallen on open-air pens. Washwater from veterinary hospitals and milking barns also may be drained into lagoons. Lagoons at swine sites usually receive wastewater collected in shallow pits directly beneath animals. Periodically, the operator pulls a plug and drains the waste into an anaerobic lagoon located adjacent to the production barns. Conversion of waste to methane and carbon dioxide gases has proven to be an effective way to remove 50 to 80 % of the manure solids that initially enter a lagoon. Furthermore, up to 80% of the nitrogen in the raw waste is lost into the atmosphere as ammonia. The remaining wastewater eventually evaporates or is applied to nearby farmland, while undigested organic solids and sediments (soil from wind and water erosion) slowly accumulate on the bottom of the lagoon.

How did K-State get involved with lagoon research?

In 1997, Kansas State University was asked to determine if animal waste lagoons, built according to KDHE standards, would meet the ¼ per day seepage standard that was recommended by the state. This concern was stimulated by the expansion of cooperate hog farming in southwestern Kansas. Large swine waste lagoons (e.g. 5 acres, 20 ft deep) were being built across the region, and there was a concern that seepage losses might pollute the drinking water. It is important to realize that Kansas, like most states, sets "design standards" not "performance standards". That is, a lagoon must be designed to seep less than some specified amount, but no one measures the seepage rate after it is built to see if it performs within the standard. K-State was asked to measure actual seepage from working lagoons across the state.

How did you measure seepage from lagoons?

The best way to measure seepage from an existing lagoon is by using the water balance method. Basically, we ask the cooperator not to add or remove waste from the lagoon for about one week. We then use very sensitive instruments to measure the change in depth and evaporation over time. If it does not rain or snow, we calculate seepage as the difference between the change in depth and evaporation. For example, suppose we measured the water balance of a lagoon for one week and detected a total depth change of 1.5 inches with an evaporation loss of 0.8 inches. The seepage rate would then be (1.5 inches – 0.8 inches) / 7 days or 0.1 inches per day. Because changes in depth must be measured very precisely, we developed custom sensors and instruments for the lagoon project. Our sensors can monitor lagoon depth every 10 seconds, 24 hours a day with a resolution greater than 1/100th of an inch.

What were the seepage rates from the lagoons you studied in Kansas?

We have conducted seepage studies on 14 lagoons in Kansas (12 swine and 2 cattle feedlots). Seepage rates have ranged between 0.02 inches/day to 0.1 inches/day . The average of all 14 sites was 0.047 inches/day (1/21"). Thus, all of the lagoons we have studied so far have seeped less than the ¼ inch/day standard. A new study of 28 lagoons in Iowa shows almost the same results.

Your data show that seepage from lagoons is probably less than ¼ inch per day, but are those seepage rates safe? Could very low rates of seepage still contaminate drinking water?

That is a good question, but a very complicated one from a scientific standpoint. When considering the potential effects of lagoons on groundwater, three areas must be considered: (a) toxicity and concentration – what are the constituents in the lagoon waste that pose a threat to water quality and public health, (b) input loading – at what rate does waste seep from a lagoon under field conditions, and (c) aquifer vulnerability – how does soil properties, geology, and water table depth affect the risk of waste movement from the lagoon to the groundwater? K-State research is trying to address all of these issues.

What in a lagoon might affect groundwater quality ?

There are several things in a lagoon that might impact groundwater quality. Potential contaminants include: nutrients, bacteria, viruses, pharmaceuticals, and hormones. It would take a long time to go through all of these in detail, but in the majority of cases, we are concerned most about nitrates and fecal bacteria. Nitrates can cause infant methemglobinemia and have been linked to types of gastric cancer. Cases of methemglobinemia are extremely rare. Bacteria like fecal streptococci and fecal coliform are very common in lagoon waste and can cause acute gastric problems if consumed in drinking water. Cases of bacteria seeping through the soil profile and contaminating groundwater are also very rare.

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† This paper is written in dialogue format – questions and answers. This is an unusual way to present scientific information; however, many of these dialogues actually occurred and they provide a clear way to present our findings. For a more detailed discussion, please refer to the references listed at the end of the report.

Wha[illegible] you found from analyzing the liquid effluent in lagoons?

We have sampled the liquid effluent in lagoons across Kansas. As an agronomist, I have focused on nutrients, especially nitrogen. One of the most important things we have discovered is that there is tremendous site-to-site variability in nutrient content in the waste. Ammonium, which accounts for almost all the leachable nitrogen in lagoons, ranges from lows of 20 ppm at some cattle feedlots to as high as 2000 ppm at one swine waste lagoon. On average, the ammonium concentration in swine waste lagoons has been about 6 to 7 times higher than at cattle feedlots. This is important, because it affects input loading. That is, if a typical swine and cattle feedlot lagoon were seeping at the same rate, seven times more nitrogen would leak from the swine site. This does not mean the seepage from swine lagoons is dangerous and that cattle lagoons are safe. It simply shows that these differences exist between species. It is important to recognize that lagoon waste is not uniform. There are big variations between sites even within the same species. Some producers have waste management plans that help reduce concentrations in the waste. This greatly reduces the chance for groundwater contamination.

What happens to the nitrogen and other soluble contaminants that seep from a lagoon?

The movement of material in the zone under the lagoon is highly dependent on the properties of the soil and the hydrology of the location. Some components of the waste are readily adsorbed onto soil particles and become immobile. For example, ammonium-nitrogen is a positively charged ion that tends to stick to clay minerals, which are all negatively charged. The ability of soil to adsorb positively charged ion is proportional to the soil's cation exchange capacity or CEC. The CEC of a soil is dependent on its clay content. Clayey soils are good traps for ammonium-nitrogen, while sandy soils can only adsorb about one fourth to one sixth as much ammonium. Thus, all things being equal, contaminants from a lagoon built above sandy soils will penetrate to deeper depths compared to a lagoon above loamy or clayey soils. Other ions, such as chloride and nitrate, are negatively charged and do not stick to the soil and move more freely. The movement of negative ions and bacteria is very dependent on soil water content (soil wetness) immediately below the lagoon liner. The zone of soil between the lagoon liner and the water table is called the vadose zone. In most places in Kansas, the vadose zone becomes unsaturated (some pores are air filled) immediately below the compacted liner. In unsaturated soil, bacteria tend to get caught in microscopic air-water interfaces between soil particles. Other soluble contaminants also move very slowly in unsaturated soil. Thus, the amount of precipitation and the depth to water table in a region will strongly affect the chances of lagoon contaminants reaching the groundwater. For this reason, the risk of contamination is typically much lower in the western portion of the state where conditions are more arid and the depth to groundwater often exceeds 150 ft.

What have you found from analyzing soil cores collected beneath lagoons?

We have collected soil cores beneath five older lagoons that have been emptied and cleaned of sludge. The sites included three cattle feedlots, a dairy, and one municipal lagoon. We are still analyzing the soil samples, but we do have some preliminary results. Data show that most of the ammonium nitrogen has been adsorbed within a few feet of the lagoon. A lot of the ammonium was trapped in the clay materials that were used to make the compacted liners. In one case, the ammonium concentrations exceeded 800 ppm near the original bottom of the lagoon; however, at this same site, which had clayey soils, none of ammonium had penetrated more than 6 ft below the lagoon. This demonstrates the importance of soil CEC and clay content. We have found some ammonium at depths near 16 ft beneath lagoons when soil in the vadose zone had a high sand content and minimal clay; however, this was rare and the concentrations were quite low. One must be careful not to assume the any lagoon built above sandy soil is source of pollution. For example, we found virtually no ammonium in soil beneath an 11-year-old cattle feedlot lagoon where the water table was only about 4 ft below the bottom of the lagoon. It happened that concentrations of ammonium in the lagoon effluent at this site were extremely dilute because the operator had good management practices. Thus, the aquifer was vulnerable, but the toxicity of the lagoon effluent was so low it did not affect groundwater quality. More analysis of the soil cores will be presented in later reports.

Have you been able to reach any conclusions regarding lagoons and groundwater quality?

Our research clearly shows that the potential impact of lagoons is very site specific and species specific. Earthen-lined lagoons can probably be used safely at many locations throughout the state; however, we need to develop design tools that regulators can use to customize lagoon requirements for each permit. Plastic-lined lagoons may be needed in certain areas. I have recently completed a manuscript that describes a logical framework for arriving at site-specific lagoon designs. Soil properties and water table depth at the proposed construction site are combined with data on species and waste management plans to calculate a maximum allowable seepage rate. The approach is quite simple and user friendly. The key to any successful approach will be to design a system that gives engineers and producers the flexibly to explore many possible approaches to lagoon design. Building a lagoon in regions of low environmental risk or employing waste treatment technologies that reduce toxicity must be rewarded with lower construction costs (e.g., soil lined vs. plastic-lined lagoons).

References

Ham, J.M. 1999. Estimating evaporation and seepage losses from lagoons used to contain animal waste. Trans. of ASAE 42:1303-1312.

Ham, J.M., and DeSutter, T.M. 1999. Seepage losses and nitrogen export from swine waste lagoons: A water balance study. J. Environ. Qual. 28:1090-1099.

Ham, J.M., L. Reddi, L. and C.W. Rice. 1999. Animal waste lagoon water quality study. Kansas Center for Agric. Resources and the Environment. College of Agric., Kansas State University, Manhattan, KS.