Approved March 28, 1989
Date

MINUTES OF THE Senate COMMITTEE ON Agriculture.

The meeting was called to order by Senator Allen
Chairperson
at

10:11 a.m./~~p.~~m. on March 22, 19 89 in room 423-S of the Capitol.

All members were present except: Senator Harder (excused)

Committee staff present: Raney Gilliland, Legislative Research Department
Lynne Holt, Legislative Research Department
Jill Wolters, Revisor of Statutes Department

Conferees appearing before the committee: Chris Wilson, Kansas Fertilizer and Chemical Association
Wilbur Leonard, Committee of Kansas Farm Organizations
Glen Searcy, Supervisor, Agricultural Commodities Assurance Program, Division of Inspections, State Board of Agriculture
Joe Lieber, Kansas Cooperative Council
Margaret Ahrens, Kansas Chapter of Sierra Club
Kansas Natural Resource Council

Senator Allen called the committee to order; called attention to copies provided the committee (attachment 1) of a letter from Vernon McKinzie thanking the committee for their efforts on SB 3; and then called committee attention to HB 2422 and the following to testify as proponents.

Chris Wilson gave the committee copies of testimony (attachment 2).

During committee discussion Ms. Wilson answered that prison help had not been discussed for use with any of the construction that will be necessary for the building of containment facilities for fertilizers that will prevent contamination.

Wilbur Leonard provided the committee with copies of his testimony (attachment 3).

Glen Searcy provided copies of nis testimony (attachment 4) for the committee.

In answer to the question Mr. Searcy stated that HB 2422 pertained only to fertilizers stored permanently, that is for over 60 days.

Joe Lieber handed copies of his testimony to the committee (attachment 5). Mr. Lieber expressed support for HB 2422 but expressed concern that some fertilizer dealers may be forced out of business or that some dealers will no longer be able to sell fertilizers because the cost of the contamination free storage areas may be too costly.

During committee discussion it was pointed out that fertilizers do not pollute the air, as they can the groundwater supply, and that anhydrous ammonia is regulated under separate regulations.

Margaret Ahrens provided the committee with copies of her testimony and a pamphlet from the Cooperative Extension Service, Kansas State University concerning nitrates and groundwater (attachment 6).

During committee discussion the question was asked as to how the amounts of nitrates in wells forty years ago compared to 1989 readings. It was suggested that readings today represent very refined testing equipment compared to equipment of a number of years ago. It was suggested that when a new containment facility has to be built that the type of

construction needs to be considered so that it is a type that the fertilizer could not destroy.

The Chairman declared the hearing closed for HB 2422 and called for committee action.

Senator Montgomery moved the committee recommend HB 2422 favorably for passage; seconded by Senator Lee; motion carried.

The Chairman called for committee action on SB 337. The Chairman explained that state funding needed to be provided through September 30, 1991, instead of through June 30 which is the end of our state budget year, so that the FACTS Program would be eligible for matching federal funds because the federal budget year ends on September 30.

Senator Doyen made a motion the committee amend SB 337 to be in effect through September 30, 1991. Seconded by Senator Sallee. Motion carried.

Senator Montgomery made a motion the committee recommend SB 337 favorably for passage as amended. Seconded by Senator Doyen. Motion carried.

The Chairman called for action on committee minutes.

Senator Sallee made a motion the committee minutes of March 16 be approved; seconded by Senator Daniels; motion carried.

Senator Allen adjourned the committee at 10:50 a.m.

GUEST LIST

COMMITTEE: Senate Agriculture DATE: March 22, 1989

| NAME | ADDRESS | ORGANIZATION |
|---|---|---|
| Glen H Searcy | Topeka Ks | KS BA |
| David Frazey | Wichita | Guest of Senator Daniels |
| DeVern H. Phillips | Topeka | KSBA |
| Scott C. Bampert | Topeka | KSBA |
| Steve Montgomery | Topeka | Ks. Legal Services |
| Tom Tunnell | Topeka | K Grain & Feed Assn |
| Alan Steppat | Topeka | Pete McGill & Associates |
| Wilbur Leonard | Topeka | Comm Ks Farm Org |
| Warren Parker | Manhattan | Kansas Farm Bureau |
| STAN WARD | Ks Bd of Ag | MANHATTAN |
| LARRY D. WOODSON | TOPEKA | Ks Bd of Ag. |
| Kenneth M. Wilke | " | " " " " |
| Don Snethen | Topeka | KDHE |
| Sam Brownback | Topeka | KSBA |
| Joe Lieber | Topeka | Ks. Co-op Council |
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KANSAS TERMITE &

PEST CONTROL ASSOCIATION INC



March 16, 1989

The Honorable Jim Allen
State Capitol Building
Topeka, KS 66612

Dear Senator Allen:

Thank you and the other members of the Senate Agriculture Committee for the work you did on Senate Bill 3. On behalf of the Kansas Termite and Pest Control Association, I express our gratitude.

We believe this bill, if passed by the House, will result in safer and more effective pesticide use in Kansas. It will certainly allow us to legally perform pesticide applications at less than label rates as long as they are effective.

Certainly all commercial applicators will benefit as a result of the two minor changes in the law relating to minimum deductibles and forms required. The state agency should also realize an easing of their paperwork burden.

Senator Sallee was also helpful with the sub-committee. I commend his firm fairness.

As the 1989 legislative session moves toward adjournment, I wish you success in dealing with the issues before you.

If there is anything our association or I can do for you or the committee, please contact us.

Sincerely,

Vernon McKinzie

Vernon McKinzie
Legislative Chairman

P.S. Extra copies are enclosed for distribution to the committee.

VM:gw

Senate agriculture
3-22-89
attachment 1

**KANSAS FERTILIZER AND CHEMICAL ASSOCIATION, INC.**
816 S.W. Tyler St. P.O. Box 1517 A/C 913-234-0463 Topeka, Kansas 66601-1517

STATEMENT OF THE KANSAS FERTILIZER AND CHEMICAL ASSOCIATION
TO THE SENATE AGRICULTURE COMMITTEE
SENATOR JIM ALLEN, CHAIRMAN
REGARDING H.B. 2422
MARCH 22, 1989

Mr. Chairman and Members of the Committee, I am Chris Wilson, Director of Governmental Relations of the Kansas Fertilizer and Chemical Association (KFCA). KFCA is the professional trade association of the Kansas agricultural chemical industry, with over 500 members. We appreciate the opportunity to comment today regarding H.B. 2422, which provides authority to the State Board of Agriculture to develop regulations for the bulk storage and handling of fertilizers.

KFCA strongly supports this bill and has worked with the Board of Agriculture since last spring toward the development of this legislation. The Board currently has regulations for the storage of pesticides in bulk, but not for fertilizers. While groundwater contamination has not been as great a concern with fertilizers, we are particularly concerned about potential contamination from storage areas, which could result from tank leaks or runoff from dry storage, and from runoff from washing and loading sites. Some of our members have already constructed containment facilities to prevent contamination at storage and loading/rinsing sites. We believe it is important that the industry as a whole adopt containment practices.

We have a Bulk Fertilizer Task Force, the members of which worked to draft H.B. 2422. KFCA also has a number of other activities related to groundwater protection, including ongoing dealer/applicator education programs and work by the Groundwater Committee to establish standards for housekeeping and best management practices.

As dealers install containment facilities at their fertilizer plants, each site will be different and have varying needs, and therefore varying costs. However, to give you an example of what one member

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attachment 2

recently spent to revamp an existing plant, we have attached a sheet listing his costs. We expect that costs for upgrading existing plants could range from $10,000 to $75,000 per plant, although some members have already spent much more than that amount. Within that range, the cost to the industry (assuming 650 plants, which is a rough estimate), would be $6.5 to 48.75 million.

Speaking last week at the National Grain and Feed Association, EPA region VII's Chief of the Groundwater Office, Tim Amsden, cited Kansas as the leading state in industry self-regulation for agricultural chemicals. We are proud of that record. The bill you have before you reflects our industry's commitment to self-regulation for environmental protection.

We respectfully ask you to favorably recommend H.B. 2422. I would be glad to respond to any questions you may have.

###

REVAMP OF AN EXISTING FERTILIZER
AND CHEMICAL PLANT

For construction of a 40' X 80' diked area and 40' X 40' loading pad:

PAD:

| | | |
|---|---|---|
| Dirt Work | | $ 700.00 |
| Concrete for dike and load pad | | 9,200.00 |
| Sand and rock | | 1,800.00 |
| Liner | | 5,600.00 |
| | TOTAL | $17,300.00 |

FOR STORAGE BUILDING:

| | | |
|---|---|---|
| 40' X 40' building | | $12,600.00 |
| Electrical work | | 1,900.00 |
| Heating | | 1,400.00 |
| Fertilizer & chemical plumbing | | 3,400.00 |
| | TOTAL | $19,300.00 |

| | |
|---|---|
| TOTAL FOR FACILITY | $36,600.00 |

Committee f . . .

# Kansas Farm Organizations

**Wilbur G. Leonard**
Legislative Agent
109 West 9th Street
Suite 304
Topeka, Kansas 66612
(913) 234-9016

STATEMENT IN SUPPORT OF HOUSE BILL NO. 2422

BEFORE THE SENATE COMMITTEE ON AGRICULTURE

March 22, 1989

Chairman Allen and Members of the Committee:

I am Wilbur Leonard, appearing on behalf of the Committee of Kansas Farm Organizations in support of House Bill No. 2422.

This bill fills a void in the law regulating the sale and distribution of commercial fertilizers and fertilizers in bulk. The board of agriculture would be authorized to establish minimum standards for the construction or substantial alteration of existing facilities used for the manufacture, storage and handling of such fertilizer materials. Emphasis is placed upon the confinement of spills and the recovery of fertilizer materials which are spilled.

It places the responsibility where it belongs, on those persons storing and handling the materials. It grants to the secretary of the state board of agriculture the necessary authority to accomplish the objectives set forth in the bill and to take appropriate action against those persons who disregard their responsibilities.

Thank you for the privilege of expressing the views of our members.

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attachment 3

PRESENTATION TO THE SENATE COMMITTEE ON AGRICULTURE

By Glen H. Searcy, Supervisor
ACAP Division of Inspections

Good morning Mr. Chairperson, and members of the Senate Committee on Agriculture. My name is Glen Searcy, Supervisor in the Agricultural Commodities Assurance Program, Division of Inspections, with the Kansas State Board of Agriculture.

H.B. 2422 addresses fertilizers, authorizing the Board of Agriculture to adopt rules and regulations for the safe handling and storage of fertilizers and fertilizer materials. These Rules and Regulations will establish minimum general standards covering the design, construction, location, installation and operation of the storage and handling of commercial fertilizers and bulk fertilizer materials to prevent contamination of ground and surface waters, through confinement of spills or discharges, for prompt recovery. As the issues of the environment and water quality are a concern to all Kansans it is important that we (the Board of Agriculture) take an active role to assure that fertilizer products are stored and handled in a safe manner to prevent accidental releases of fertilizer thus contaminating these resources. Anhydrous ammonia will be exempt since it is addressed in separate regulations. The regulations will address permanent storage and not cover temporary portable storage, such as tip tanks.

We will work with industry and interested groups and others to develop rules and regulations requiring those facilities that handle fertilizer to have the proper safety equipment, to contain spills and promptly clean-up all accidental releases. Five states in the midwest have already adopted similar laws (Minnesota, Oklahoma, Iowa, Illinois and Wisconsin) and other states are considering initiation of some type of containment legislation.

There are several reasons for allowing the Kansas State Board of agriculture to adopt these types of regulations:

1 Industry is requesting that some requirements for containing fertilizer at their facilities be established. The types of requirements sought deal with containment walls, load and unload pads, equipment locking requirements (i.e. padlocks on valves), and other safety requirements to prevent spills from occurring and to assure cleanup is done when they do occur.

2. The Kansas State Board of Agriculture is presently calling on these facilities performing safety inspections for anhydrous ammonia and sampling other fertilizer products. These inspectors are qualified to perform these additional duties.

3. The state will have containment requirements in place and would not have to rely on federal agencies to perform inspections or dictate requirements.

It is our opinion that there would be substantial economic impact on industry and farmers affected by these regulations, however, until regulations are passed specifying the exact requirements, the amount of this impact is not known nor can it be predicted by us. Industry may have a better feel for this in their testimony. However, it is in mutual interest of the citizens of Kansas to establish minimum requirements.

Fiscal impact upon the agency is minimal. We already have 8 field inspectors conducting inspections at these facilities, additional field staff is not necessary. One additional clerical position will be required to process the forms and a half time administrator will be required to review forms to assure requirements are met and follow-up to provide compliance. printing of laws, forms, travel for administrative staff, and other office supplies will be required. This is a fee funded program and we do not anticipate any increase in the fees already being submitted.

This bill will enable current field staff to better regulate fertilizer products by allowing, not just the product to be inspected, but also the storage and handling at the fertilizer facility. The requirements of H.B. 2422 are similar to those in the pesticide containment regulations. We feel this is for the betterment of Kansas.

If consideration is given to a certain threshold amount it will interface with S.B. 94. This bill will affect farmers as well as fertilizer dealers who store agricultural fertilizer. Regulations under H.B. 2422 could provide different requirements for fertilizer being stored for resale and that fertilizer stored temporarily for the owners use only. If exemptions are made within H.B. 2422 as opposed to the regulations - those facilities exempted would be immediately impacted by S.B. 94, Health and Environment's regulation of storage containers.

If you have any questions, I or our staff, will be glad to answer them for you.

Testimony on HB 2422
Senate Committee on Agriculture
March 22, 1989
Prepared by Joe Lieber
Kansas Cooperative Council

Mr. Chairman and members of the Committee: For the record I'm Joe Lieber, Executive Vice President of the Kansas Cooperative Council. The Council has a membership of nearly 200 cooperatives that have as their members nearly 200,000 Kansas farmers and ranchers.

The Council supports HB 2422 because we too want to prevent fertilizer materials from being introduced into the ground or surface water of our state.

Even though we do support the bill, we would like to express a concern that we have at this time.

As the Board of Agriculture established these regulations and sets the dates for compliance we hope they are conscious of the cost to the fertilizer dealers. If the requirements are too expensive and the dates too soon, many dealers may be forced out of business or at least out of the fertilizer business.

Not only would we hate to see these dealers forced out of business, but it would limit the number of dealers the farmer could choose to do business with.

We have no reason to believe that the Department of Agriculture is not sympathetic to these concerns, but we did feel that they needed to be expressed.

Thank you.

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# SIERRA CLUB

## Kansas Chapter

HB2422

Regulation of Handling, Storage and Disposal of Commercial Fertilizers and Fertilizers in Bulk

Testimony Before Senate Committee on Agriculture

March 22, 1989

I am Margaret Ahrens, representing the 2200 members of the Kansas Chapter of the Sierra Club, and speaking today also on behalf of The Kansas Natural Resource Council. Our volunteer organizations have longstanding concerns for the protection of our natural resources. We know that prevention of contamination is consistently the LEAST costly effort when compared with health costs and clean-up once contamination has occurred. We support HB2422 because of its potential for protecting groundwater from contamination due to concentrated leaching of fertilizers at points of handling, storage and disposal.

Although consistent high-quality testing of farm wells in Kansas is not yet a reality, in two completed phases of a Kansas farmstead well study, 28% and 30% of the wells had nitrate levels exceeding the 44ppm U.S. Public Health Service standard of safety for humans and livestock. Of those wells exceeding 44ppm, about half exceeded 88ppm. The KSU Water Quality Bulletin attached prescribes 88ppm+ in this way:

"Short-term use acceptable for human adults and all livestock unless food or feed sources are very high in nitrates. Long-term chronic use could be risky."

HB2422 recognizes fertilizer handling areas as sources of intensified nitrate leachate with potential to contaminate groundwater. Similar alterations in the Kansas Pesticide Law would provide a needed control on the handling of pesticides.

We commend the industry for this regulatory effort and strongly urge that you vote favorably on HB2422.

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attachment 6

SIERRA CLUB
Kansas Chapter

**Margaret Post Ahrens**
Lobbyist

4400 S.W. 17th St.
Topeka, Kansas 66604 (913) 273-7346

WATER QUALITY

# Nitrates and Groundwater

Groundwater supplies about 50 percent of the drinking water in the United States. In rural areas, as much as 85 percent of the drinking water is from groundwater. Nearly 70 percent of Kansans rely on groundwater as their source of drinking water. Consequently, protection of groundwater from contamination by any substance that might cause health problems is a serious concern.

One potential contaminant of groundwater is nitrate ($NO_3$). A recent survey of rural water wells in Kansas found 28 percent of the wells with nitrate levels higher than the National Public Health Service drinking water standard.

This fact sheet addresses nitrates and their effect on groundwater including: human and livestock health concerns, extent of nitrates in groundwater, sources of nitrates in groundwater, and ways to minimize the risk of nitrate contamination of groundwater.

## Health Concerns

***Human:*** Humans ingest nitrates in food and water, and nitrates are absorbed readily from the digestive tract. In older children and adults, nitrates are ingested, absorbed, and excreted promptly in the urine. Healthy human adults can consume fairly large amounts of nitrate with little known short-term effect. The health effects of chronic, long-term consumption of high levels of nitrates are uncertain and are the subject of current research.

Infants under 3 to 6 months old are susceptible to nitrate poisoning because of bacteria present in their digestive systems at birth. Because newborn infants have little acid in the digestive tract, they depend on these bacteria to help digest food. Generally, by the age of 3 to 6 months, hydrochloric acid levels in the baby's stomach increase and kill most of the bacteria that convert nitrate to nitrite.

The primary health concern of nitrates is due to the reduced form of nitrate called "nitrite." The bacteria in the digestive tract of young infants can change nitrate into nitrite, which is toxic. The nitrite is absorbed and enters the bloodstream where it reacts with the oxygen-carrying hemoglobin, forming a compound called "methemoglobin." High levels of methemoglobin interfere with the blood's ability to carry oxygen. As oxygen levels decrease, subjects may show signs of suffocation. This condition is called "methemoglobinemia."

The major symptom of methemoglobinemia is bluish skin color, most noticeably around the eyes and mouth. Death can occur when 70 percent of the hemoglobin has been converted to methemoglobin. Methemoglobinemia can be treated successfully with an injection of methylene blue, which changes methemoglobin back to hemoglobin. Treatment must occur quickly, however.

Infant deaths from methemoglobinemia, sometimes called "blue baby," are rare but have been documented; some have been linked to high levels of nitrate in well water. Doctors now recommend using bottled water to make formula when nitrate levels exceed the U.S. Public Health Service drinking water standard of 44 parts per million (ppm). With one possible exception, no breast-fed infants have developed methemoglobinema—an observation attributed to rapid nitrate excretion by the mothers.

Another health concern with nitrates is a possible interaction with organic compounds (secondary amines) to form N-nitrosoamines, known to be active carcinogens. There are many organic compounds which could link with nitrates to form N-nitrosoamines, including some pesticides. This may be especially noteworthy since wells with high nitrate levels are often vulnerable to pesticide contamination. Immediate and chronic health concerns of N-nitrosoamines to humans are not well understood.

***Livestock:*** Nitrate poisoning is most likely in ruminant animals such as cattle and sheep. Bacteria present in the rumen convert nitrate to toxic nitrite.

For a safe water supply:

- ☐ Ensure safe well construction
- ■ **Protect water from contamination**
- ☐ Get recommended water tests
- ☐ Select treatment based on tests
- ☐ Save and compare test results



6-2

Monogastric animals such as swine and chickens have no rumen and most of the nitrate is rapidly eliminated in the urine. Young monogastric animals, like human infants, have a high degree of susceptibility until their digestive systems develop. Horses are monogastric, but their large cecum acts much like a rumen in that bacteria present are capable of converting nitrate to nitrite. Because of this, horses are more susceptible to nitrate poisoning than other monogastric animals.

While some plants naturally contain potentially harmful levels of nitrate, water rarely does. High-nitrate water is generally a health hazard to animals only when it adds to high nitrate concentrations already present in some feeds.

Symptoms of methemoglobinemia in animals include: lack of coordination, labored breathing, blue coloring of mucous membranes, vomiting, and abortions. Dairy cows, however, can have reduced milk production without showing any symptoms. If animals show signs of nitrate poisoning or a problem is suspected, a veterinarian should be consulted to determine if nitrate is the problem and, if necessary, administer the antidote—an injection of methylene blue.

***Water testing:*** If nitrates in drinking water are suspected, either for humans or livestock, a routine water sampling and testing program should be initiated so nitrate levels in the water can be monitored. Nitrates are undetectable in water or feeds without testing as they are colorless, odorless, and tasteless. In Kansas, the Department of Health and Environment or several private testing laboratories can perform this service.

Most laboratories report the nitrate content as parts per million (ppm) of either nitrate ($NO_3$) or nitrate-nitrogen ($NO_3$–N). To interpret the results, it is critical to know if results are reported as $NO_3$ or $NO_3$–N. To convert $NO_3$–N to $NO_3$, multiply by 4.4. For example, 10 ppm $NO_3$–N is equivalent to 44 ppm $NO_3$. The table below gives some general guidelines for water use.

**Guidelines for Use of Water with Known Nitrate Content**

| Nitrate ($NO_3$) level (ppm) | Nitrate-Nitrogen ($NO_3$–N) level (ppm) | Interpretation* |
|---|---|---|
| 0–44 | 0–10 | U.S. Public Health Service standard is 44 ppm $NO_3$ or 10 ppm $NO_3$–N. Safe for humans and livestock. |
| 45–88 | 11–20 | Generally safe for human adults and livestock. Do not use for human infants. |
| 89–176 | 21–40 | Short-term use acceptable for human adults and all livestock unless food or feed sources are very high in nitrates. Long-term, chronic use could be risky. |
| 177–440 | 41–100 | Risky for human adults and young livestock. Probably acceptable for mature livestock if feed is low in nitrates. |
| Over 440 | over 100 | Should not be used. |

*Interpretations are primarily based on short-term effects. Chronic, long-term risks are not fully understood.

## Extent of Nitrates in Groundwater

Even though nitrates, both naturally occurring and from other sources, are a common groundwater contaminant in the United States, the severity of nitrate contamination is hard to assess. Researchers agree that nitrate concentrations in unpolluted groundwater seldom exceed the 44 ppm standard. Recent United States Geological Survey (USGS) data show that almost every state has areas where nitrate levels exceed the standard. About 6 percent of the total wells sampled in this survey had nitrate concentrations exceeding 44 ppm.

The USGS study, while documenting that nitrates are commonly found in groundwater, was not a statistically valid sample of groundwater conditions. Some of the wells were sampled because of suspected contamination, and there was poor sampling consistency.

A recent Environmental Protection Agency (EPA) study of rural water supplies may provide more valid data. Nationwide, this survey found only 2.7 percent of rural wells exceeding the 44 ppm standard.

Several recent studies, however, reveal trends that are a concern. Work in Nebraska, Iowa, and Kansas has shown localized areas where nitrates have been increasing. For example, surveys conducted along the upper Des Moines River Basin in Iowa found 20–30 percent of the wells exceed the 44 ppm drinking water standard for nitrates.

In Kansas, a random survey of 104 farmstead wells conducted from December 1985 through February 1986 showed 28 percent of the wells had nitrate levels of 44 ppm or higher. Of the wells with nitrate levels exceeding 44 ppm, about half exceeded 88 ppm.

A recently completed second phase of this study, which sampled an additional 84 wells, showed very similar results. About 30 percent of the wells had nitrate levels above the standard.

While the data in general indicate that nitrate contamination of groundwater has not been a widespread problem, it is a concern in some areas of the Midwest, including Kansas and adjacent states.

## Sources of Nitrates in Groundwater

Understanding where nitrates come from and how they reach groundwater requires a knowledge of two aspects of our natural world—the nitrogen cycle and groundwater recharge.

***The nitrogen cycle:*** Worldwide, nitrogen is the plant nutrient most limiting for food production. Since

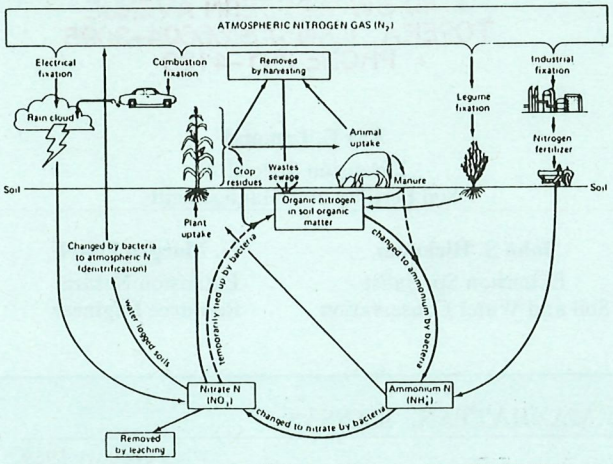
early times, people have sought to add nitrogen to crops by using animal wastes, human wastes, legumes, or fertilizers.

Nitrogen is an important part of the environment. The air we breathe is 78 percent nitrogen gas ($N_2$). Nitrogen accumulates in soils during the process of soil formation. Virgin prairie soils contain as much as 6,000-10,000 pounds per acre of organically bound nitrogen. Once soil is tilled and crops are grown, organic matter content tends to decrease. As organic matter is oxidized, inorganic nitrogen is released, which is available primarily as nitrate ($NO_3$) to the growing crops. This is shown in the illustration of the nitrogen cycle (Figure 1). Nitrogen can enter this cycle at several points and from several sources. This cycle operates in a native ecosystem (forest or grassland) as well as a farming ecosystem.

In some natural ecosystems, nitrogen is almost always in short supply; nitrogen cycling is very efficient, with low losses. In other natural ecosystems, however, nitrogen is abundant and loss potential is high. This explains why groundwater under natural ecosystems can be high in nitrates. In today's agriculture, with greater nitrogen inputs for higher crop yields, efficiencies of nitrogen use may be lower and the potential for losses may increase. Nitrogen not taken up by the crop can reach groundwater as nitrate.

Animal manures, human wastes, composts, sewage sludge, legume crops, and green manure crops are organic sources of nitrogen. Before this nitrogen can be used by plants it must be converted to ammonium ($NH_4$) or nitrate ($NO_3$). Some nitrogen fertilizers contain nitrogen already in the nitrate form. In other fertilizers, nitrogen is in the ammonium form, which is rapidly converted to nitrate by soil bacteria at soil temperatures above 50°F. When any nitrogen is added to the soil, either from organic or inorganic sources, it becomes a part of the soil nitrogen cycle. The total amount of nitrogen generated through the processes of the nitrogen cycle is not necessarily used by plants. When nitrogen supply is greater than the amount used by plants, potential for accumulation of nitrates in the soil and loss from the system exists, regardless of the original source.

Figure 1. The Nitrogen Cycle




**From:** *Fertilizers and Soil Amendments,* Roy H. Follett, Larry S. Murphy, and Roy L. Donahue. ©1981 by Prentice-Hall, Inc. Adapted and used with permission.

Nitrates can be lost from the system by leaching, denitrification, volatilization, and immobilization (Fig. 1). From the standpoint of groundwater quality, leaching of nitrates is the only concern. The other loss mechanisms can be important in low nitrogen efficiencies, but do not contribute directly to groundwater contamination. Leaching is the downward movement of water and nitrates through the soil. The potential for nitrate leaching varies with soil type and rainfall or irrigation. Sandy soils under high rainfall or irrigation have high leaching potential.

Nitrates, moved downward by leaching, can come from many sources, not necessarily just from fertilizers (Fig. 1). Since the downward movement of nitrate through soils was taking place before the presence of humans, it's unrealistic to expect to stop or eliminate this movement. Careless use of fertilizer, or improper management of the other nitrogen sources, however, can increase the rate of movement and magnitude of loss and must be avoided.

***Groundwater recharge:*** Groundwater is water below the land surface that totally fills or saturates a water-bearing formation. The top of this saturated zone is called the water table. Although groundwater seems to be trapped in the soil or in geologic formations, there is some movement. A water-bearing saturated zone that holds sufficient water and allows enough movement of the water to supply wells is called an aquifer.

The processes of groundwater recharge are complex. The amount of water that enters the soil and eventually recharges the groundwater varies seasonally and from area to area. During wet seasons, recharge may occur and result in shallow water tables. During dry seasons, particularly with active plant growth, water tables can be lowered. The amount of recharge and depths to the water table vary with climate, soil type, soil depth, soil permeability, topography, and geologic formations. In humid areas, considerable recharge may occur every year. In more arid regions, there may be years where no recharge occurs and water tables may be 50 to 150 or more feet deep.

In addition, different types and configurations of aquifers may affect groundwater flow. Thus, there is a chance that improvements or degradation of groundwater quality may occur over time.

As can be seen from this brief discussion of the nitrogen cycle and groundwater recharge, nitrate contamination of groundwater is a complex problem. It's clear that both nature and people can be responsible for nitrates found in groundwater. Of the human activities that contribute nitrates, agriculture and disposal of society's wastes are by far the largest share. Society's alteration of the environment to produce food and to dispose of wastes has likely resulted in increased rates of nitrate movement and increased the magnitude of nitrate losses to groundwater.

There are, however, management practices that farmers and others can use to minimize the leaching of nitrates from soils.

## Reducing Nitrate Risks

The use of nitrogen fertilizers, animal and human wastes, and legume crops will continue to supply the nitrogen necessary for crop growth. However, there is no question that improved nitrogen management can reduce the potential for groundwater contamination. Several practices are important to this goal.

First, growers need to have realistic yield goals. This may be the most effective means of decreasing nitrogen losses and reducing potential groundwater pollution. Yield goals are the heart of fertilizer rate recommendations, especially for nitrogen. Setting yield goals unrealistically high results in over-fertilization and a greater potential for nitrate carryover and potential contamination of groundwater. To arrive at an optimum nitrogen fertilizer rate, growers must consider the crop being grown, the productive capacity of the soil, and moisture availability to set a realistic yield goal.

A second important point is to consider **all** potential nitrogen sources for a crop. These include: a previous legume crop, manure, and residual nitrate already in the soil. These sources can all contribute nitrogen and may meet the total nitrogen needs of that crop. Nitrogen soil tests are recommended to determine the amounts of nitrate in the soil. Research data show clearly that over-fertilization with nitrogen can increase the risk for carry-over nitrates that may eventually reach groundwater.

A third management practice is timing of nitrogen fertilizer application. On coarse-textured, highly permeable soils, split or sidedress applications of nitrogen generally result in increased nitrogen efficiency and decreased potential for nitrogen loss because of the shorter time between fertilizer application and crop uptake. On medium- and fine-textured soils, time of application is not as critical.

Additionally, nitrification inhibitors can be used to improve nitrogen fertilizer efficiency on coarse-textured, sandy soils. These inhibitors inactivate the soil bacteria that mediate conversion of ammonium to nitrate. As long as nitrogen is in the ammonium form, it will not leach.

A final point to consider is placement of fertilizers, sludges, or manures. Much of the recent research indicates greater nitrogen efficiency in terms of crop uptake with injection or deep incorporations of nitrogen fertilizers and manure or sewage sludge. Any management practice that results in more of the applied nitrogen being taken up by the crop lessens the potential for nitrate contamination of groundwater.

Nitrogen management practices can exert a strong influence on groundwater quality. Use of the proper rate of nitrogen is probably the most important factor, but the other management practices also can be important.

Is it possible to correct a groundwater nitrate problem once it exists? It can be done, but the necessary procedures are costly and not totally effective. The best option, by far, is to keep excess nitrates from entering the groundwater.

This fact points out the importance of careful selection of well sites. Wells should not be located close to septic system lateral fields, livestock confinement sites, sludge pits, lagoons, or other sites where high soil nitrogen levels would be expected.

## Summary

The purpose of this fact sheet has been to provide some insight into nitrates and groundwater. High nitrate levels in water are a health concern. Nitrates can reach groundwater from many sources and certainly not all are of agricultural origin. Whatever the source, we need to be concerned about minimizing nitrate movement into our groundwater.

In short, we do not have a complete picture of groundwater contamination by nitrates. We do, however, have enough information to know that it is a growing problem in many parts of the country, including Kansas. Recommended practices that minimize risks of nitrate contamination should be given careful and immediate attention.

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MF-857 Revised February 1989



File Code: Engineering 4-5 (Water Quality)