# Comments on the Potential Regional Economic Effects of Large Feedlots

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Note: This paper is divided into two sections. The first section discusses current research findings concerning the regional economic impacts from large, concentrated animal feeding operations (CAFOs). The second discusses the factors inherent in these operations that create the impacts discussed in Section 1.

## Section 1—Economic impacts from large, concentrated animal feeding operations

### Interference with Amenities and Property Values

Amenities are those characteristics that make a region pleasant or a desirable residence. Amenities differ from one region to another, but each amenity helps create a quality of life that draws people to an area and makes them want to stay there. Large CAFOs tend to diminish local amenities:

A. In a 2001 study of farming dependent areas , Tweeten and Flora found that if they create environmental problems newly developed or arrived CAFOs may undermine a community's opportunities to expand its economic base. They also found that the vertical coordination structure used by large CAFOs can cause a loss of resources from farms and rural communities because CAFO facilities tend to be so large and because ownership and control may reside in distant metropolitan centers. All else being equal, they found the productivity gains attributed to large CAFOs decrease aggregate employment and other economic activities in rural communities. [1]

B. In 2001, John Kilpatrick of Mundy Associates, the leading US appraisal and property stigma analysis firm, determined that "diminished marketability, loss of use and enjoyment, and loss of exclusivity can result in diminishment ranging from 50% to 90% of [the] otherwise unimpaired value" of property located in the vicinity of a CAFO.[2]

C. Actual property tax adjustments by county assessors in at least eight states confirm these lowered property taxes for neighbors of CAFOs. As Table 1 shows, local property tax assessments have been lowered in Alabama, Illinois, Iowa, Kentucky, Maryland, Michigan, Minnesota and Missouri.

**Table 1--Property Tax Reductions In Areas Around CAFOs**

| Area | Amount of Reduction | Reduction In Value Of: |
|---|---|---|
| Grundy Co, MO | 30% | |
| Mecosta Co, MI | 35% | dwellings only |
| Changed to | 20% | total property (land and structures) |
| Midland Co, MI | 20% | |
| DeWitt Co, IL | 30% | rescinded |
| McLean Co, IL | 35% | |
| DeKalb Co, AL | base reassessment, variable rates | |
| Renville Co, MN | base reassessment, variable rates | dwellings only |
| Humbolt Co, IA | 20-40% | dwellings only--now rescinded |
| Frederick Co, MD | 10% | now reduced to 5% |
| Muhlenberg Co, KY | 18% | dwellings only |

Radius of reduction varied, up to 2 miles. All were for hogs except Muhlenberg, for chickens.
Source: Property Tax Reductions, scott.dye@sfsierra.sierraclub.org, March 13, 2000

### The Potential Impact of CAFO Production On Regional Economies

The four economic characteristics that generally define a CAFO are fundamentally incompatible with regional economic development. Regional economic development proceeds on the premise that the wages paid and purchases made by a company are transferred to other individuals or companies in the region. The multiplier effect of these payments further assumes that they are again spent within the confines of the region and that they do not "leak" into other areas of the state or nation. However CAFOs are structured so they will not aid regional economic development for the following reasons:

(1) Constraints on Regional Economic Development Due To Employment

As a capital intensive company, a CAFO is designed to minimize the number of workers and hence, minimize the economic impact on the region. Further, large scale animal production facilities are more likely to purchase their inputs from a great distance away, bypassing local providers in the process.[3] A number of studies have found that compared with small farms with an equivalent composite production value, a large farm tends to buy a smaller share of consumption and production inputs in nearby small towns. A 1994 study by the University of Minnesota Extension Service found that the percentage of local farm expenditures made by livestock farms fell sharply as size increased. Farms with a gross income of $100,000 made nearly 95% of their expenditures locally while farms with gross incomes in excess of $900,000 spent less than 20% locally. [4]

This is important because local employment from a CAFO's operations depends on amount of purchases the CAFO and its employees make in the region. Input-output analysis shows each farm job adds another job in local communities and another in the state outside the local communities. Similarly, each $1,000 of farm income adds an-other $1,000 to local communities and another $1,000 to the state outside the local communities.[5] However, these expenditures occur only if both the CAFO and its employees live and spend their money in the region. As the previous paragraphs have shown, the CAFO is unlikely to do this, and with a local unemployment rate in the Yankton region that has been about 2-3%, it is also unlikely that employees of the facility will either come from the local community of live in the local area.

Confined animal production can occasionally benefit local feed sellers, but only when it consumes all the hay or grain produced in the county. If the county has to export one bushel of grain or one bale of hay, all the grain and hay in the county will have to be priced to compete in the export market.[6]

(2) Constraints on Regional Economic Development Due To Taxes

Federal, state and local taxes are levied on taxable amounts calculated on federal returns. The numerous tax write-offs that are possible because CAFOs are sometimes treated as industries and, at other times, treated as farms, significantly decrease the amounts of taxes paid locally. At the same time the operations of the CAFO create social, health and traffic costs that the local government must finance. The local government, in turn, must rely on increased taxes to pay these CAFO-induced costs--and this can decrease other economic activity in the region.

For example, additional costs associated with hosting a CAFO include increased health costs, traffic, accidents, road repairs, and environmental monitoring. One Iowa community estimated that its gravel costs alone increased by about 40% (about $20,000 per year) due to truck traffic to hog CAFOs with 45,000 finishing hogs. Annual estimated costs of a 20,000 head feedlot on local roadways were $6447 per mile due to truck traffic.[7] Colorado counties that have experienced increases in livestock operations have also reported increases in the costs of roads, but specific dollar values are not available. [8]

In this case, the roads near the proposed feedlot are gravel and all maintenance expenses fall on the township and then the county. The existing oil road in the vicinity is unlikely to be capable of handling the traffic caused by the feedlot, and load limits have been posted for this road for several months. Some State money has apparently been promised for road upgrades, but it is clear that the proposed feedlot will raise road maintenance expenses for the region. Because of the many negative effects the feedlot is likely to have on local property values, t is highly unlikely that these expenses will be offset by increased tax revenues.

(3) Constraints on Regional Economic Development Due To Vertical Integration

Vertical integration requires purchases from and sales to other members of the vertically integrated company, not from local producers and suppliers. Thus, vertically integrated companies stimulate regional economies only to the extent that all elements of the company are located in the region. Historically, this factor has severely limited the economic impact of CAFOs on the regions in which they are situated.

(4) Constraints on Regional Economic Development Due To Cost Shifting

The previous three sections have described the reasons inherent in the structure of CAFOs that most of the money from a CAFO will either be directly spent outside the region or it will quickly migrate there. However, through cost shifting the CAFO will also leave the costs of its odor, health risks, surface water pollution, ground water pollution and in the long run, its abandoned lagoons and facilities for the region to deal with. For example, some of these costs may arise from:

A. The Potential Cost of Groundwater Contamination From Manure

All manure lagoons leak and this leakage can contaminate groundwater. Han found that after accounting for evaporation, seepage from lagoons averaged.05 inch. per day. The lagoons studied ranged in size from 1.24 to 6.2 acres with waste depths between 5 and 18.5 feet and all were built with compacted soil/bentonite liners. Calculated nitrogen export losses from seepage were 1826 to 2738 pounds/acre/year.[9]

Ruhl studied earthen basins with above-grade, earth-walled embankments and compacted clay liners. The hog basins held a manure-water mixture and monitoring systems were installed below the compacted clay liners both in the sides and the bottom of the basin. Seepage from the basin ranged from 400-2200 gallons per day except during one month and three month periods when 3800 to 6200 gallons per day. Seepage flow in areal units ranged from .025 to .43 inches/day. Except during the first three months when the basin was filling, seepage flow was greater through the sidewalls than through the bottom of the basin. Nitrate-N concentrations in the seepage exceeded the US Environmental Protection Agency drinking water standard of 10 mg/L in 17 of 22 samples.[10]

B. The costs of closing lagoons

In South Carolina, where the state has been forced to assume responsibility for closing hog lagoons, the cost has averaged $42,000 per surface acre of lagoon. These costs are paid by the taxpayers of state, not the companies that created the lagoons.[11]

***C. Potential costs of health-related problems***

(a) Potential Costs from Pathogens, Chemical and Antibiotics in Manure

A large number of diseases are present in animal manure. These diseases are not present in inorganic fertilizers. Table 2 shows that the potential presence of 25 different diseases in animal manure make this form of fertilizer very different from the inorganic chemicals that are used as crop fertilizer.

**Table 2, Diseases and organisms spread by animal manure**

| Disease | Responsible organism | Disease | Responsible organism |
|---|---|---|---|
| Bacterial | | Viral | |
| Salmonella | Salmonella sp | New Castle | Virus |
| Leptospirosis | Leptospiral pomona | Hog Cholera | Virus |
| Anthrax | Bacillus anthracis | Foot and Mouth | Virus |
| Tuberculosis | Mycobacterium tuberculosis | Psittacosis | Virus |
| | Mycobacterium avium | | |
| Johnes disease | Mycobacterium | Fungal | |
| | paratuberculosis | Coccidioidomycosis | Coccidoides immitus |
| Brucellosis | Brucella abortus | Histoplasmosis | Histoplasma capsulatum |
| | Brucella melitensis | Ringworm | Various microsporum |
| | Brucella suis | | and trichophyton |
| Listerosis | Listeria monocytogenes | Protozoal | |
| Tetanus | Clostridium tetani | Coccidiosis | Eimeria sp. |
| Tularemia | Pasturella tularensis | Balantidiasis | Balatidium coli. |
| Erysipelas | Erysipelothrix rhusiopathiae | Toxoplasmosis | Toxoplasma sp. |
| Colibacilosis | E.coli (some serotypes) | | |
| Coliform mastitis | E.coli (some serotypes) | Parasitic | |
| Metritis | | Ascariasis | Ascaris lumbricoides |
| | | Sarcocystiasis | Sarcocystis sp. |
| Rickettsial | | | |
| Q fever | Coxiella burneti | | |

Source: Agricultural Waste Management Field Handbook, United States Department of Agriculture Soil Conservation Service, April, 1992, p. 3-13, 3-14.

(i) Campylobacter

Berndtson et al. (1996) isolated Campylobacter from flies netted in anterooms of barns containing positive broiler flocks in Sweden. Urban and Broce (1998) isolated Salmonella and three other kinds of bacteria from 43% of house flies and blow flies netted around dog kennels in Kansas, where meat from a neighboring rendering plant was the main food for the dogs. And recently, Iwasa et al. (1999) isolated the enterotoxic E. coli O157:H7 from 1.6% of house flies netted directly from cattle manure piles at 1 of 4 dairy farms in Hokkaido, Japan. Collectively, these studies demonstrate that varying percentages of flies netted around animals and their manures can harbor isolatable loads of potentially pathogenic bacteria.[12]

A wide variety of wild and domestic animals also serve as reservoirs of Campylobacter that normally colonize their gastrointestinal tract (Angulo, 1997). The foods that have been implicated in outbreaks are milk, poultry and red meat (Varnam and Evans, 1991). A relatively large number of outbreaks are water-borne, because this pathogen has the ability to survive in water in an infectious state (Nachamkin, 1997). From a subset of the NAHMS 1996 national dairy study herds tested using a PCR test, 100% of herds tested had positive cows with an individual milk cow prevalence of 43%. [13]

(ii) Salmonella

A variety of animal species are reservoirs of infection, including cattle, swine, and poultry. Information from the NAHMS 1996 national dairy study indicates at least 28% of dairy operations have milk cows shedding Salmonella at any point in time (Wells et al., 1998). There is also evidence of clustering of Salmonella on certain dairy operations.[14]

In Germany, Salmonella was detected in 50% and 36% of samples of biowaste and fresh compost, respectively. The seepage water from these sources was found out to be a reservoir of Salmonella; Salmonella enteritidis survived in seepage water for 42 days at 5 $_{0}$C (Knop et al., 1996). In lake water, Campylobacter jejuni survived longer than C. coli both at 4 $_{0}$C and 20 $_{0}$C (Korhonen et al., 1991). Salmonella were found in the environment of a dairy two years after the occurrence of a clinical outbreak of salmonellosis. Samples of recycled flush water were positive for Salmonella indicating that hardy organisms can become established in the environment of modern free-stall dairies that use recycled water in their manure flush systems (Gay and Hunsaker, 1993). [15]

(iii) E. coli

Cattle are considered the primary reservoir of human infection from E. coli O157, though other species including dogs, horses, flies, and birds have cultured positive (Hancock et al., 1998). From the NAHMS 1996 national dairy study, 24% of dairy herds had at least one culture-positive milk cow, with a milk cow prevalence of about 1% (Wells et al., 1998). These estimates are consistent with those from the NAHMS 1995 national feedlot study (63% of feedlots, with higher sampling per feedlot, and 1% of fecal samples). Typical duration of shedding is short. [16]

The source of transmission for a large number of E. coli outbreaks has been confirmed to be cattle asymptomatically infected with E. coli O157:H7 (Rajkowski, et al. 1998). Direct transmission from cattle to humans has also been documented (Armstrong et al., 1996). [17] Because cattle are a natural reservoir of E. coli O157:H7, more than 30 surveys have been conducted in the U. S., U.K and Europe to determine the prevalence of this pathogen in feces of bovine populations. Herd prevalence between 22% and 100% indicated that E. coli O157:H7 is widespread in both beef and dairy cattle where the prevalence appears to be highly variable within herds (Armstrong et al., 1996; USDA/APHIS, 1997). The median percentage of E. coli positive animals within herds calculated from those studies was 1.7 %, and the range varied from 0 in four cases to 63% in a recent report (Jackson et al., 1998). [18]

(iv) Listeria monocytogenes

Weber found 33% of 138 German cattle shedding Listeria monocytogenes in feces (1995). Risk factors among French farms included poor quality of silage (pH > 4.0), inadequate frequency of cleaning the exercise area, poor cow cleanliness, insufficient lighting of milking barns and parlors, and incorrect disinfection of towels between milkings (Sanaa, 1993). [19] Listeria can survive and grow at refrigeration temperatures; ready-to-eat meats have been implicated in many outbreaks. This is a characteristic that distinguishes this bacterium from other foodborne pathogens, even a few contaminant cells can be enough inoculum to reach infectious dose levels (Bell and Kiriakides, 1998). [20]

(v) Cryptosporidium parvum

Cryptosporidium parvum is important as a water-borne pathogen. Many different species of animals shed C. parvum oocysts, including cattle. Oocyst shedding appears to be clustered in young calves (primarily less than 30 days of age) and efforts to detect shedding of oocysts from cows around the time of calving have failed to date (Atwill et al., 1998). Because of the clustering of fecal shedding in very young calves, environmental control may be feasible, with focus on preventing calf feces from contaminating surface water. [21] There have been 14 documented incidents of cryptosporidium disease outbreaks in U.S. and Canada since 1984 (Frey et al., 1998). Four of these events were linked to nonpoint source agricultural pollution, the others were primarily caused by septic tank and human sewage contamination.[22]

The pathogens present in manure are not found in inorganic chemicals. These pathogens could be transported to ground water supplies through improperly sealed wells or other naturally occurring pathways. Many incidents of human disease attributable to contact with livestock waste have been reported. Stanley et al. (1998) isolated Campylobacter jejuni from groundwater in the Arnside area of Cambria. Some of the strains isolated were of the same biotype as the ones from a dairy farm situated within the hydrological catchment of the polluted spring indicating that the groundwater was a vehicle for bacterial transmission. In a longitudinal study of four dairy farms, it was suggested that E. coli O157:H7 was disseminated from a common source on these farms and that this strain could persist in the herd for up to 2 years (Shere et al., 1998).[23]

Large numbers of viruses are excreted in infected animal feces. In fact, enteroviruses have been found in all animal species that have been extensively studied. These animal viruses can gain entrance to streams, lakes and other bodies of water via land application of animal wastes or by direct contamination from pastures and feedlots. Constant fecal contamination of open water in pastures and washings of pens, closed lots and dairy operations are important in this respect. (Malherbe et al., 1967). [24]

(b) Potential costs of odors

There is evidence that odors from concentrated animal facilities can produce real illnesses in affected populations adjacent to these facilities. A report by the State Health Director of North Carolina notes that exposure to environmental odors results in physiological stresses that may result in a variety of symptoms including headache, nausea, loss of appetite, and emotional disturbance. Odors may exacerbate stress-related illnesses. The symptoms may result from odor annoyance, stress associated with odor exposure, and conditioned responses to odors. The literature also reports that exposure to odors may exacerbate asthma symptoms.[25] The following excerpts of articles address human response to environmental odors:

N. P. Shukia (1991) "In the case of humans, the immediate physiological stresses produced by odors can cause loss of appetite and food rejection, low water consumption, poor respiration, nausea, and even vomiting, and mental perturbations. In extreme cases, offensive odors can lead to deterioration of personal and community well-being, interfere with human relations, deter population growth and lower its socio-economic status."[26]

Dennis Shusterman (1992) "Environmental odor pollution problems generate a significant fraction of the publicly-initiated complaints received by air pollution control districts. Such complaints can trigger a variety of enforcement activities under existing state and local statutes. However, because of the transient timing of exposures, odor sources often elude successful abatement. Furthermore, because of the predominantly subjective nature of associated health complaints, air pollution control authorities may predicate their enforcement activities upon a judgment of the public health impact of the odor source. Noxious environmental odors may trigger symptoms by a variety of physiologic mechanisms, including exacerbation of underlying medical conditions, innate odor aversions, aversive conditioning phenomena, stress-induced illness, and possible phenomenal reactions."[27]

Shim and Williams (1986) "Many patients complain that some odors worsen their asthma. Perfume and cologne are two of the most frequently mentioned offenders. A survey of 60 asthmatic patients revealed a history of respiratory symptoms in 57 on exposure to one or more common odors. Odors are an important cause of worsening of asthma. From a practical standpoint, sensitive asthmatic patients should be advised to eliminate odors from their environment as much as possible."[28]

Susan Knasko (1993) "The effects of intermittent bursts of pleasant, unpleasant, and no experimental odor on human task performance, mood, and perceived health were tested in this study.

Odors did not influence any of these measures; however, subjects who had been exposed to the malodors reported retrospectively that they thought the odors had a negative effect on all of these factors."[29]

Pierre Caralini (1994) "With regard to general health complaints, it was found that when exposed to odorant concentrations, some people are annoyed and of these people, only some report general health complaints. Exposure in itself does not directly cause general health complaints. Annoyance is the intervening variable between exposure and general health complaints. A possible explanation for the relation between annoyance by malodor and general health complaints might be found in the personality and attitudes of the exposed individual. Finally, we found confirmation for the appraisal hypothesis, i.e., the extent to which individuals regard malodor as threatening is positively related to odor annoyance."[30]

Shusterman, et. al. (1991) "Retrospective symptom prevalence data, collected from over 2000 adult respondents living near three different hazardous waste sites, were analyzed with respect to both self-reported 'environmental worry' and frequency of perceiving environmental ("particularly petrochemical) odors. Significant positive relationships were observed between the prevalence of several symptoms (headache, nausea, eye, and throat irritation) and both frequency of odor perception and degree of worry. Headaches for example, showed a prevalence odds ratio of 5.0 comparing respondents who reported noticing no such odors and 10.8 comparing those who described themselves as 'very worried' versus 'not worried' about environmental conditions in their neighborhood."[31]

**Summary—Economic Impacts**

Costs such as those discussed above can directly affect both long and short run regional economic development. As Tweeten and Flora note, costs of odor-, waste-, and pest-control need to be charged to the producing units and not to their neighbors or to other “downstream” parties.[32] Unfortunately, the costs of CAFOs are currently charged to the residents of the region and the regional effect of this cost shifting is felt both in its impacts on current residents and on those residents and businesses that do not move to the region due to the presence of these costs. Put bluntly, every company and every potential resident have many choices of location and active recruitment is practiced by most regions. Quality of life is a major factor in decisions to locate in a region, and neither companies nor potential residents would never consider locating in an area where a large CAFO is operating.

## Section 2—Factors Inherent in CAFO Operations That Create the Negative Economic Impacts Discussed in Section 1

### A. Proposed Feedlot Manure Volume and Characteristics:

One reason the concept of diminishing returns should be a powerful deterrent to large CAFOs is that the cost of responsibly handling and treating animal waste is very high. Anaerobic decomposition in animal waste lagoons is less effective at eliminating human pathogens and BOD. As opposed to assumptions about its natural and thus, harmless, nature, livestock manure creates pollution with a strength that far exceeds raw municipal sewage. As Table 3 shows, the BOD concentration in undiluted livestock waste is 160 times more powerful than raw municipal sewage and ammonia is 200 times more concentrated. Even after it has been flushed to lagoons, manure effluent is still 57 times more powerful than raw sewage.

**Table 3. Pollution strength of livestock and municipal waste**

| Type of Waste | BOD5 mg/l | Ammonia, $NH_4N$ mg/l |
|---|---|---|
| Undiluted Livestock Waste | 40,000 | 10,000 |
| Manure Lagoon Effluent | 14,400 | - |
| Runoff From a Concrete Lot | 1,000 | - |
| Runoff From a Dirt Lot | 500 | - |
| Raw Municipal Sewage | 250 | 50 |
| Treated Municipal Sewage | 30 | 1.5 |

Source: Understanding the Pollution Potential of Livestock Waste, Illinois Environmental Protection Agency, 1991.

Exposure of land-applied wastes to sunlight and microbial activity in the soil will generally finish the job of pathogen control, and the nutrients that affect BOD may be used by crop plants. In effect, application to farm land is a final step in the "treatment" of animal waste if the amount of land to which it is applied is sufficient to perform this function.[33] The need to apply animal waste from CAFOs to the land to destroy human pathogens in the waste requires the construction of lagoons to hold the effluent until it can be applied to the land.

All of this implies that the feedlot has enough land for responsible nutrient application, and it further implies that the number of animals in the feedlot has been decided based on the amount of spreadable acreage available--and not vise-versa. It also implies a climate that is mild enough to allow year-round application, or sufficient, leak-free lagoon capacity to see the feedlot through the winter months. In sum, the requirement to spread the waste to kill pathogens creates a significant decision point in the ability of the CAFO to responsibly handle waste.

Securing the amount of spreadable acreage required by a large feedlot is usually a daunting task. If the feedlot is located in an area like South Dakota where the climate is unfavorable for waste application for major parts of the year or where the soil is so poor that few crops are grown and little spreading can occur, spreading the waste on the land may simply be impractical.

The first step in selecting and sizing a manure-handling system is to estimate how much manure and wastewater are generated. Table 4 lists manure production data, characteristics, and nutrient content for typical livestock types and weights. The manure nutrient values are for fresh manure and urine without storage and handling losses. Average values are listed and some variation can be expected due to animal age, feed ration, type of confinement, method of manure handling, and other factors.

**Table 4. Annual Raw-Manure Production per 1,000-Pound Animal Weight**

| Animal Type | Manure Production Tons/yr | Gal/yr | Percent Solids | Nutrient Content N lb/ton | $P_2O_5$ lb/ton | $K_20$ lb/ton | N lb/1,000 gal | $P_2O_5$ lb/1,000 gal | $K_20$ lb/1,000 gal |
|---|---|---|---|---|---|---|---|---|---|
| Dairy | 15 | 3614 | 12.7 | 10.0 | 4.1 | 7.9 | 41.5 | 17.0 | 32.8 |
| Beef | 11 | 2738 | 11.6 | 11.3 | 8.4 | 9.5 | 45.4 | 33.7 | 38.2 |
| Veal | 11.5 | 2738 | 8.4 | 8.7 | 2.1 | 9.0 | 36.5 | 8.8 | 37.8 |

**Source:** Ohio Livestock Manure And Wastewater Management Guide, Bulletin 604, Section 15, http://oh.nrcs.usda.gov/fotg/OhioNRCSstandards1.htm, 1979-1999 various.

**Based on the data in this table, the total amount of manure generated by the 22,700 cattle on this proposed South Dakota feedlot will be about 250,000 tons per year or 684 tons per day. This equates to over 62 million gallons of animal manure each year.**

## B. Flush Water Required by the Proposed Feedlot

Because this feedlot uses a liquid manure system to dispose of its waste, flush water will be required to transport the manure to the lagoons. Based on data from the US Department of Agriculture, the amount of flush water required by a feedlot is approximately 100 gallons per head per day. (See Table 5)

**Table 5. Recommended total daily flush volumes (MWPS 1985)**

| **Animal type** | **gal/head** |
|---|---|
| Dairy cow | 100 |
| Beef feeder | 100 |

Source: Agricultural Waste Management Field Handbook, US Department of Agriculture, Soil Conservation Service, April, 1992, p. 10-5.

**Given these data, the proposed South Dakota feedlot can be expected to use 2,270,000 gallons of water per day or 828,550,000 gallons or 2541 acre feet of water annually for manure flushing. (1 acre-foot of water contains about 326,000 gallons.)**

## C. Lagoon Seepage:

The liquid generated in the calculations above will be stored on the proposed feedlot in lagoons with a surface area of 9-12 acreas. Using Han and Ruhl's findings that seepage flow in areal units ranged from .025 to .43 inches/day, estimated seepage from the lagoons proposed for the South Dakota feedlot waste in this project would be[34]:

Assume a conservative seepage rate of .05 inches per day for 9-12 acres of lagoons.

One acre = 43,560 sq. feet.

.05 inches = .0042 feet

therefore, one acre will leak 181 cubic feet or 1354 gallons per day

this equates to roughly 500,000 gallons per year per acre of lagoon.

**Thus, the proposed lagoons for the South Dakota feedlot are expected to leak from 4.5 million to 6 million gallons of manure effluent per year.**

This leakage could have a serious impact on the Lower James-Missouri Aquifer which is about 80 - 100 feet below ground level in this area and is estimated to contain 2.08 million acre-feet of recoverable water.

## D. Nutrient Availability

Plans for the proposed feedlot evidently envision both solid and liquid manure application. Table 6 lists characteristics of “as excreted” beef manure. Beef waste from feedlots can vary widely because of such factors as climate, diet, feedlot surface, animal density, and cleaning frequency. The soil in unsurfaced beef feed-lots is readily incorporated with the manure because of the animal movement and cleaning operations. Wasted feed is an important factor in the characterization of beef wastes. Beef feedlot runoff water also exhibits wide variations in character. The influencing factors that are responsible for feedlot waste variations are similar to those listed for solid wastes. Surfaced feedlots produce more runoff than unsurfaced lots.

**Table 8 Beef waste characterization — feedlot manure**

| Component | Units | Unsurfaced - -lot* | - - Surfaced lot** | |
|---|---|---|---|---|
| | | | High forage diet | High energy diet |
| Weight | lb/d/1000# | 17.50 | 11.70 | 5.30 |
| Moisture | % | 45.00 | 53.30 | 52.10 |
| TS | % w.b. | 55.00 | 46.70 | 47.90 |
| | lb/d/1000# | 9.60 | 5.50 | 2.50 |
| VS | " | 4.80 | 3.85 | 1.75 |
| FS | " | 4.80 | 1.65 | 0.75 |
| N | " | 0.21 | | |
| P | " | 0.14 | | |
| K | " | 0.03 | | |
| C:N ratio | | 13 | | |

* Dry climate (annual rainfall less than 15 inches); annual manure removal.
** Dry climate; semiannual manure removal.
Source: Agricultural Waste Management Field Handbook, US Department of Agriculture, Soil Conservation Service, April, 1992, p. 4-11.

**Irrespective of how the spreading is accomplished, adjusting these numbers for the number of animals, the total amount of nutrients excreted annually by cattle on the proposed South Dakota feedlot would be approximately:**

**N = 1,740,000 pounds**
**P = 1,160,000 pounds**
**K = 260,000 pounds**

While the amount of nitrogen actually available for application will vary considerably depending on how the manure is handled, the phosphorus and potassium applied to the soil will be available unless removed by surface runoff and soil erosion. Nearly 100 percent of total phosphorus and potassium from manure application are considered available the first growing season. **The manure contains much more potassium than magnesium or calcium, and after many years of continued manure application, the ratio of potassium to magnesium and calcium may be too high for optimum crop growth. To adjust the ratio, additional magnesium and/or calcium may have to be added.** [35]

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