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STATE OF MINNESOTA
POLLUTION CONTROL AGENCY
POLICY AND PLANNING DIVISION

In the Matter of Proposed Amendments to Minnesota Rules Relating to Animal Feedlots, Storage, Transportation, and Utilization of Animal Manure

STATEMENT OF NEED AND REASONABLENESS

Minn. R. pt. 7001.0020
Minn. R. pt. 7002.0210 to 7002.0280
Minn. R. ch. 7020

December 8, 1999

I. INTRODUCTION

The Minnesota Pollution Control Agency (MPCA or agency) is proposing to revise the existing rules governing issuance procedures for permits regulating animal feedlots and manure storage areas, Minn. R. pt. 7001.0020, related permit fees, Minn. R. pt. 7002.0210 to 7002.0280, and related permit requirements and technical standards associated with pollution prevention, Minn. R. ch. 7020. The application of manure to land is also governed primarily by Minn. R. ch. 7020. The Minnesota Administrative Procedures Act requires a statement of need and reasonableness (SONAR) justifying and explaining the need for revisions to the existing rule. This document fulfills that requirement.

The feedlot rules contain a set of requirements and standards that are intended to control the discharge of pollutants from feedlots to the environment. The rules apply to all aspects of livestock production including the location, design, construction, operation and management of feedlots and manure handling facilities. Swine and dairy confinement facilities, pasture and winter-grazing operations, poultry facilities, and composting sites are examples of livestock production operations and manure processing facilities that are subject to these rules.

Minn. R. ch. 7020 has not been revised since 1978. Many changes have occurred since 1978 that create the need to revise the feedlot rules. Livestock production techniques and practices have changed dramatically. There have been new discoveries and understandings regarding agriculture and the environment. The MPCA and its partner counties have also acquired a lot of experience administering the animal feedlot regulatory program. Finally, regulatory strategies have evolved and these strategies require rule changes to implement. The rule revision process is an opportunity to respond to these changes and seek public input to the proposed changes. Parts of the rule currently ineffective are deleted or revised; and new parts are developed for areas previously not addressed. Therefore, the revision should benefit the public, the environment, and the regulated community.

The rule revision development processes began in early 1995. The rule development process included a substantial effort to involve concerned parties, which is discussed in more detail under Additional Notice, Section VI, of this SONAR.

In the more than twenty years since Minn. R. ch. 7020 was last revised, much has changed in the agricultural industry. In response to these changes, the agency began an effort to re-design this program in 1995. After evaluating the existing rules, administrative processes, and status of environmental impact from animal feedlots and manure storage areas, revised goals were identified. The agency's goals for revising the rules are to:

- Focus on animal feedlots, manure storage areas and pastures that have the greatest potential for environmental impact;
- Expand the role of delegated counties in the feedlot program;
- Increase agency and delegated-county staff field presence; and
- Achieve the desired environmental outcomes with existing agency and county resources.

Further discussion of these goals and how they influenced this rulemaking is included in the Reasonableness as a Whole and in the Reasonableness by part discussions.

The Office of the Legislative Auditor recently conducted an extensive evaluation of the current MPCA animal feedlot regulatory program. The findings are in the report called, "Animal Feedlot Regulation: A Program Evaluation Report (January 1999)." See Exhibit G-1. This Report guided the agency in the development of the proposed rules. Among the comments made in the Report were the need for: better oversight of permitted and unpermitted animal feedlots, manure storage areas and pastures; better oversight and coordination with delegated counties; and a "need to develop a better strategy to correct water pollution hazards." Exhibit G-1, page 81.

There are five major sections in the proposed rules: 1) permit fees; 2) registration program; 3) permit program; 4) delegated county program; and 5) standards for discharge, design, construction, operation and closure. Permit fees are discussed in this SONAR under parts 7002.0210 to 7002.0280; the registration program is discussed under part 7020.0350; the permit program is discussed under parts 7020.0400 to 7020.0535; the delegated county program is discussed under parts 7020.1600; and the technical standards are discussed under parts 7020.2000 to 7020.2225.

The agency is proposing that the owner of an animal feedlot, manure storage area, or pasture be required to apply for a permit if, for example, the owner's facility:

- Is required by federal regulations to be covered under a NPDES permit;
- Is a pollution hazard; or
- Has been required to implement mitigation measures or alternative designs/operations during an environmental review process.

The agency is also proposing a streamlined permit process for owners with animal feedlots and manure storage areas with more than 300 and fewer than 1,000 animal units and that meet specific eligibility criteria. This streamlined permit is called a construction short-form permit and the corresponding permit conditions are specified under parts 7020.0405 to 7020.0535. The need for and reasonableness of the rules proposed in these parts are discussed in this document.

This statement of need and reasonableness can be made available in other formats, including Braille, large print and audio tape. If you are interested in obtaining this SONAR in another format, please call TTY: (651) 282-5332 or 1-800-657-3864.

II. MPCA'S STATUTORY AUTHORITY

The MPCA's statutory authority to develop and adopt the proposed rules is set forth in a number of statutes, including Minn. Stat. ch. 115 and 116, and federal regulations. For example, Minn. Stat. § 115.03, subd. 1, paragraphs (e)(1), (2), (3), (4) and (7), (f) and (g) which provides the MPCA with the powers and duties to:

> (e) To adopt, issue, reissue, modify, deny, or revoke, enter into or enforce reasonable orders, permits, variances, standards, rules, schedules of compliance, and stipulation agreements, under such conditions as it may prescribe, in order to prevent, control or abate water pollution, or for the installation or operation of disposal systems or parts thereof, or for other equipment and facilities;
>
> > (1) Requiring the discontinuance of the discharge of sewage, industrial waste or other wastes into any waters of the state resulting in pollution in excess of the applicable pollution standard established under this chapter;
> >
> > (2) Prohibiting or directing the abatement of any discharge of sewage, industrial waste, or other wastes, into any waters of the state or the deposit thereof or the discharge into any municipal disposal system where the same is likely to get into any waters of the state in violation of this chapter and, with respect to the pollution of waters of the state, chapter 116, or standards or rules promulgated or permits issued pursuant thereto, and specifying the schedule of compliance within which such prohibition or abatement must be accomplished;
> >
> > (3) Prohibiting the storage of any liquid or solid substance or other pollutant in a manner which does not reasonably assure proper retention against entry into any waters of the state that would be likely to pollute any waters of the state;
> >
> > (4) Requiring the construction, installation, maintenance, and operation by any person of any disposal system or any part thereof, or other equipment and facilities, or the reconstruction, alteration, or enlargement of its existing disposal system or any part thereof, or the adoption of other remedial measures to prevent, control or abate any discharge or deposit of sewage, industrial waste or other wastes by any person; . . .
> >
> > (7) Requiring the owner or operator of any disposal system or any point source to establish and maintain such records, make such reports, install, use, and maintain such monitoring equipment or methods, including where

> appropriate biological monitoring methods, sample such effluents in accordance with such methods, at such locations, at such intervals, and in such a manner as the agency shall prescribe, and providing such other information as the agency may reasonably require; . . .
>
> (f) To require to be submitted and to approve plans and specifications for disposal systems or point sources, or any part thereof and to inspect the construction thereof for compliance with the approved plans and specifications thereof;
>
> (g) To prescribe and alter rules, not inconsistent with law, for the conduct of the agency and other matters within the scope of the powers granted to and imposed upon it by this chapter and, with respect to pollution of waters of the state, in chapter 116, provided that every rule affecting any other department or agency of the state or any person other than a member or employee of the agency shall be filed with the secretary of state;

Additional authority is set forth in Minn. stat. § 115.03, subd. 5, which provides:

> Agency authority; National Pollutant Discharge Elimination System. Notwithstanding any other provisions prescribed in or pursuant to this chapter and, with respect to the pollution of waters of the state, in chapter 116, or otherwise, the agency shall have the authority to perform any and all acts minimally necessary including, but not limited to, the establishment and application of standards, procedures, rules, orders, variances, stipulation agreements, schedules of compliance, and permit conditions, consistent with and, therefore not less stringent than the provisions of the Federal Water Pollution Control Act, as amended, applicable to the participation by the state of Minnesota in the National Pollutant Discharge Elimination System (NPDES); provided that this provision shall not be construed as a limitation on any powers or duties otherwise residing with the agency pursuant to any provision of law.

Additional authority is set forth in Minn. stat. § 116.07, subd. 2 and 4. For example, subdivision 2 provides for management of manure when it is not used as a fertilizer and persons operating feedlots and dealing with manure may be required to meet other rules established by the agency that address air quality and hazardous waste issues. Subdivision 4 also addresses air quality issues and other matters related to feedlots. For example, subdivision 4, second paragraph, provides for general rulemaking authority and reads, in part, as follows:

> Pursuant and subject to the provisions of chapter 14, and the provisions hereof, the pollution control agency may adopt, amend, and rescind rules and standards having the force of law relating to any purpose within the provisions of Laws 1969, chapter 1046, for the collection, transportation, storage, processing, and disposal of solid waste and the prevention, abatement, or control of water, air, and land pollution which may be related thereto, and the deposit in or on land of any other material that may tend to cause pollution . . . Without limitation, rules or standards may relate to collection, transportation, processing, disposal, equipment, location, procedures, methods, systems or techniques or to any other matter

> relevant to the prevention, abatement or control of water, air and land pollution which may be advised through the control of collection, transportation, processing, and disposal of solid waste and sewage sludge, and the deposit in or on land of any other material that may tend to cause pollution . . .

Additional authority is set forth in Minn. stat. § 116.07, subd. 4d, paragraph (a), which provides:

> The agency may collect permit fees in amounts not greater than those necessary to cover the reasonable costs of reviewing and acting upon applications for agency permits and implementing and enforcing the conditions of the permits pursuant to agency rules. Permit fees shall not include the cost of litigation. The agency shall adopt rules under section 16A.1285 establishing a system for charging permit fees collected under this subdivision. The fee schedule must reflect reasonable and routine permitting, implementation, and enforcement costs. The agency may impose an additional enforcement fee to be collected for a period of up to two years to cover the reasonable costs of implementing and enforcing the conditions of a permit under the rules of the agency. Any money collected under this paragraph shall be deposited in the special revenue account.

Additional authority is set forth in Minn. stat. § 116.07, subd. 7, as amended, which provides:

> Subd. 7. Counties; processing of applications for animal lot permits. Any Minnesota county board may, by resolution, with approval of the pollution control agency, assume responsibility for processing applications for permits required by the pollution control agency under this section for livestock feedlots, poultry lots or other animal lots. The responsibility for permit application processing, if assumed by a county, may be delegated by the county board to any appropriate county officer or employee.
>
> (a) For the purposes of this subdivision, the term "processing" includes:
>
> (1) the distribution to applicants of forms provided by the pollution control agency;
>
> (2) the receipt and examination of completed application forms, and the certification, in writing, to the pollution control agency either that the animal lot facility for which a permit is sought by an applicant will comply with applicable rules and standards, or, if the facility will not comply, the respects in which a variance would be required for the issuance of a permit; and
>
> (3) rendering to applicants, upon request, assistance necessary for the proper completion of an application.
>
> (b) For the purposes of this subdivision, the term "processing" may include, at the option of the county board, issuing, denying, modifying, imposing conditions upon, or revoking permits pursuant to the provisions of this section or rules promulgated pursuant to it, subject to review, suspension, and reversal by the pollution control agency. The pollution control agency shall, after written

notification, have 15 days to review, suspend, modify, or reverse the issuance of the permit. After this period, the action of the county board is final, subject to appeal as provided in chapter 14.
(c) For the purpose of administration of rules adopted under this subdivision, the commissioner and the agency may provide exceptions for cases where the owner of a feedlot has specific written plans to close the feedlot within five years. These exceptions include waiving requirements for major capital improvements.
(d) For purposes of this subdivision, a discharge caused by an extraordinary natural event such as a precipitation event of greater magnitude than the 25-year, 24-hour event, tornado, or flood in excess of the 100-year flood is not a "direct discharge of pollutants."
(e) In adopting and enforcing rules under this subdivision, the commissioner shall cooperate closely with other governmental agencies.
(f) The pollution control agency shall work with the Minnesota extension service, the department of agriculture, the board of water and soil resources, producer groups, local units of government, as well as with appropriate federal agencies such as the Natural Resources Conservation Service and the Farm Service Agency, to notify and educate producers of rules under this subdivision at the time the rules are being developed and adopted and at least every two years thereafter.
(g) The pollution control agency shall adopt rules governing the issuance and denial of permits for livestock feedlots, poultry lots or other animal lots pursuant to this section. A feedlot permit is not required for livestock feedlots with more than ten but less than 50 animal units; provided they are not in shoreland areas. These rules apply both to permits issued by counties and to permits issued by the pollution control agency directly.
(h) The pollution control agency shall exercise supervising authority with respect to the processing of animal lot permit applications by a county.
(i) Any new rules or amendments to existing rules proposed under the authority granted in this subdivision or to implement new fees on animal feedlots, must be submitted to the members of legislative policy and finance committees with jurisdiction over agriculture and the environment prior to final adoption. The rules must not become effective until 90 days after the proposed rules are submitted to the members.
(j) Until new rules are adopted that provide for plans for manure storage structures, any plans for a liquid manure storage structure must be prepared or approved by a registered professional engineer or a United States Department of Agriculture, Natural Resources Conservation Service employee.
(k) A county may adopt by ordinance standards for animal feedlots that are more stringent than standards in pollution control agency rules.
(l) After January 1, 2001, a county that has not accepted delegation of the feedlot permit program must hold a public meeting prior to the agency issuing a feedlot permit for a feedlot facility with 300 or more animal units, unless another public meeting has been held with regard to the feedlot facility to be permitted.

Minnesota statutes also provide additional permit authority and is set forth in Minn. stat. § 116.07, subd. 7c, (1998), which reads in part:

> Subd. 7c. NPDES permitting requirements.
> (a) The agency must issue National Pollutant Discharge Elimination System permits for feedlots with 1,000 animal units or more based on the following schedule:
> (1) for applications received after April 22, 1998, a permit for a newly constructed or expanded animal feedlot with 2,000 or more animal units must be issued as an individual permit;
> (2) for applications received after January 1, 1999, a permit for a newly constructed or expanded animal feedlot with between 1,000 and 2,000 animal units that is identified as a priority by the commissioner, using criteria established under paragraph (e), must be issued as an individual permit; and
> (3) after January 1, 2001, all existing feedlots with 1,000 or more animal units must be issued an individual or general National Pollutant Discharge Elimination System permit.
> (b) . . .
> (e) By January 1, 1999, the commissioner, in consultation with the feedlot and manure management advisory committee, created under 17.136, and other interested parties must develop criteria for determining whether an individual National Pollutant Discharge Elimination System permit is required under paragraph (a), clause (2), for an animal feedlot with between 1,000 and 2,000 animal units. The criteria must be based on proximity to waters of the state, facility design, and other site-specific environmental factors.
> (f) By January 1, 2000, the commissioner, in consultation with the feedlot and manure management advisory committee, created under section 17.136, and other interested parties must develop criteria for determining whether an individual National Pollutant Discharge Elimination System permit is required for an existing animal feedlot, under paragraph (a), clause (3). The criteria must be based on violations and other compliance problems at the facility.

Additional authority to adopt these rules is set forth in other sections of Minn. Stat. ch. 115 and 116, including Minn. stat. § 115.03, subd. 1(a) and 1(b); 115.04; 115.06, subd. 3; 115.07; 116.07, subd. 4a; 116.07, subd. 4d; 116.07, subd. 7a; 116.081; and 116.091. The agency is also the delegated Minnesota state agency to implement and administer the Clean Water Act's NPDES program. Under that delegation, the agency has duties, obligations and authorities under Title 40 Code of Federal Regulations (CFR) part 122, including part 122.23, for the permitting of NPDES-covered sites and facilities and under 40 CFR 412, related to effluent limitation regulations and standards for the specified feedlot categories.

Under the above-cited statutes, the agency has the necessary statutory authority to adopt the proposed rule.

III. NEED FOR THE RULES

Minn. Stat. ch. 14 requires the agency to make an affirmative presentation of facts establishing the need for its proposed rules or amendments. In general terms, this means that the agency must set forth reasons for its proposal, and the reasons must not be arbitrary or capricious. The term, need, is used to mean a problem exists that requires administrative attention. The need for a revision of feedlot rules is discussed in three parts: contaminants associated with manure; specific needs supporting revisions of the existing rules; and discussions contained in the reasonableness for individual parts of the proposed rules.

A. Overview of Livestock and Poultry Operations in Minnesota

An estimated 40,000 animal feedlot, manure storage and pasture facilities exist in Minnesota with over 10 animal units, and thousands of these feedlots are located in shoreland areas. Minnesota's ranking among other states for livestock related production is listed Table 1.

Table 1. Minnesota's National Ranking for Livestock Related Production.

Type of Production (1997)	Rank Nationally
Turkeys raised	2nd
Hogs marketed	3rd
Milk production/# of milk cows	5th
Red meet production	6th
Eggs produced	9th

Source - Minnesota Agricultural Statistics (1998). See Exhibit A-16.

Livestock at these facilities produce the amount of waste, which is produced by roughly 60 million people. It is important to prevent the contaminants in manure from moving from the animal holding areas, manure storage areas, and manure application areas into surface and ground water supplies. The Minnesota Pollution Control Agency has the responsibility to regulate the collection, transportation, storage, processing, and disposal of animal manure for the prevention and abatement of water, air, and land pollution. Therefore, the MPCA needs to establish rules to prevent manure from becoming a pollutant and causing unwanted environmental effects.

In manure, the constituents most impacting water quality include phosphorus, nitrogen, biological oxygen demand, and disease causing organisms (pathogens). Other contaminants may include trace metals and hormones. Human health and the environment are put at risk from these water quality impact factors. The problems caused by contaminants or the results of contaminants in the environment have different pathways of entry and source areas. Various types of gaseous compounds emanating from manure are an additional human health and environmental concern.

B. Overview of Minnesota Water Quality Assessments

Watershed projects conducted through the Minnesota Clean Water Partnership Program have diagnosed water quality problems in 37 project sites throughout the state. Sixteen projects identified feedlots as significant contributors of nonpoint source contamination to lakes and streams. While the statewide effects of contaminants from manure have not been completely separated from other nonpoint sources of pollution, it is clear that surface water quality is being impacted from agricultural sources in general, which includes discharges and runoff from feedlots and manure application sites.

Rivers and lakes are described, under the federal and state clean water programs, based on their ability to meet water quality standards. An impaired water body is one that pollutant levels exceed safe levels for the particular pollutant. Thus, the waterbody no longer fully supports its designated uses. These designations may include uses as water supply, recreation, wildlife, industrial consumption, and aesthetics.

In an assessment of nonpoint source pollution throughout the state, the MPCA concluded the following in the Minnesota Nonpoint Source Management Program – 1994 report about some of the impacts experienced by water bodies in this state. See Exhibit A-17.

Of the 12,241 river miles assessed by monitoring data:

- Nonpoint sources of pollution were reported to contribute to the degradation of 63 percent of the assessed river miles;
- 90 percent of the surveyed river miles were significantly impacted (either impaired or threatened of impairment) by agricultural sources including irrigated and non-irrigated cropland, pastures, feedlots, animal holding/management areas and agri-chemicals;
- About 37 percent of the impaired river miles had heavy algae and weed growth problems resulting in low oxygen levels;
- Elevated bacteria were identified in half to two-thirds of the impaired river miles; and
- All parts of the state have threatened and impaired stream conditions.

Of the 2.1 million lake acres assessed by monitoring data:

- Nonpoint sources of pollution were reported to contribute to the degradation of 43 percent of the assessed lake acres;
- 64 percent of the surveyed lake acres were significantly impacted (either impaired or threatened of impairment) by agricultural sources including irrigated and non-irrigated cropland, pastures, feedlots, animal holding/management areas and agri-chemicals;
- About 90 percent of the impaired lakes had heavy algae blooms and weed growth resulting in low oxygen levels;
- Elevated bacteria were identified as problems in nearly half of the impaired lakes; and
- All parts of the state have threatened and impaired lake conditions, but the southern half of the state has a much higher percentage of impaired and threatened lakes than the northern half of the state. For example, the Minnesota River basin in southern Minnesota

> has nearly 40 percent of the lakes impaired and an additional seven percent threatened to become impaired, largely from agricultural sources. Whereas, the Lake Superior Basin in northern Minnesota has about five percent of the lakes impaired and another 12 percent threatened to become impaired, with a lower percentage affected by agriculture.

Manure is only one of several nitrogen sources that can lead to elevated nitrate in ground water. The volume of manure generated, the widespread application of manure, and the close proximity of feedlots to rural wells make manure a potential risk to human health and the environment. The agency needs to develop a program for animal feedlot and manure management that reduces this risk.

According to "Nitrogen in Minnesota Groundwater", the 10 mg/l drinking water standard was exceeded in 1.2 percent of the 1,678 community water supply wells with measured and reported nitrate-N concentrations. See Exhibit A-2. Nitrate concentrations were elevated above background, one milligram per liter (mg/l), in another 20 percent of the wells. The percentage of private domestic wells with nitrate exceeding the drinking water standard is unknown, but is estimated from available data sets described in the "Nitrogen in Minnesota Ground Water" study to be roughly seven percent. See Exhibit A-2. Assuming seven percent of an estimated 450,000 private wells exceed the drinking water standard and an average of 3.3 people per home, then the population exposed to nitrate above drinking water standards is about 104,000. Several hundred thousand additional people are exposed to nitrate-N elevated above background, but which is still below the 10 mg/l drinking water standard. The report found that the largest source of impact was from agricultural sources. See Exhibit A-2. Thus, the need for the agency to update feedlot rules, which are more than 20 years old and are insufficient to protect the water resources of Minnesota.

The discussion that follows will focus on the main factors impacting water in Minnesota. Improper management of manure can cause impacts; poor locations for facilities; over application of manure; or improper design and construction of manure or the facilities used to store manure. A set of standards to address these activities is needed for consistency in requirements asked of feedlot owners and for protection of the environment.

C. Overview of the Primary Contaminants Associated With Manure

Phosphorus

Phosphorus is the limiting nutrient affecting weed and algae growth in most of Minnesota's lakes and streams. One pound of phosphorus will produce roughly 500 pounds of weeds or algae growth in a lake. Decomposition of weeds and algae causes a decrease in dissolved oxygen levels; thereby, affecting the entire aquatic ecosystem. Water impaired by algae, weed growth, and game-fish reductions can affect the beneficial recreational uses including swimming, water-skiing, and fishing. Water impaired by excess algae and weed growth cannot support the game fish that are valued by sport fishermen and are seen as less valuable for recreational uses also including swimming and waterskiing. Non-water contact recreational enjoyment, such as canoeing, boating, and sailing, can be greatly reduced by severe algae growth. Thus, the agency, as the responsible state entity for water quality, must give considerations to feedlot rules that reduce this sector as a large contributor to phosphorus loading to lakes and streams.

In addition to the detrimental effects caused by phosphorus on the ecosystem and human quality of life, human health can also be affected from very high levels of phosphorus. Blue-green algae are commonly found in lakes enriched with phosphorus. Large numbers of decomposing blue-green algae can cause toxicity problems. Swimmers contacting water impacted by blue-green algae will typically experience skin rashes. The cause of the skin rashes is typically unknown to the swimmer and therefore goes unreported. Aerosols from the toxic blue-green algae can cause upper respiratory effects. Humans or animals drinking water with toxic blue-green algae can also have toxic health effects. The number of people affected by blue-green algae in Minnesota is unknown. An animal that has ingested toxins from an algae bloom can show symptoms for nausea and skin irritation to severe circulatory, nervous and digestive disorders. Obviously, the need for proper manure management and animal feedlot location, design and construction is important to the economics of agriculture as it is to human health and the environment.

Phosphorus typically does not leach through soils in large quantities. However, high soil phosphorus levels can lead to phosphorus movement to ground water. The ground water once contaminated with phosphorus may serve as a conduit to surface water.

Phosphorus from animal manure can be a significant pollutant when runoff that contains manure is allowed to enter surface water. Manure-contaminated runoff most often occurs from outdoor animal holding areas and manure application sites, but can also occur from stockpile runoff or intentional pumping, piping or dumping of manure into waters. Table 2 shows typical phosphorus concentrations from various sources.

Table 2. Comparison of Phosphorus Concentration in Waters, Sewage and Manure.

Source	Phosphorus (mg/l)
Lake Water (clear)	0.02
Lake Water (green due to algae)	0.2
Municipal Sewage (treated)	1 - 4
Municipal Sewage (untreated)	8
Cattle Feedlot Runoff	85
Cattle or Hog Manure	100 to 2500

See Exhibit A-3.

Watersheds in northern Minnesota, where there is less agricultural activity, have average phosphorus loads of 0.13 to 0.21 pounds per acre per year. Whereas, watersheds in southern Minnesota have phosphorus loads of 0.84 mg/l (Heiskary and Wilson, 1994). See Exhibit A-3. In a review of the literature, a highly significant relationship shows that the greater the rate of manure applied the more phosphorus found in the runoff. See Exhibit L-2. Other studies show that when soils have higher soil phosphorus levels, the dissolved phosphorus in runoff from those soils will be higher compared to soils with lower soil phosphorus levels. See Exhibit L-5. Thus, it is necessary to establish management controls to eliminate direct manure runoff into water bodies and reduce excess phosphorus application to fields.

Relatively small amounts of manure can have detrimental effects on surface water quality. Modeling of a watershed with two lakes in LeSeuer County indicated that by improving the three worst feedlots, phosphorus loading reductions of 30 to 40 percent could be achieved. A lake restoration project in Redwood County focused on improving three feedlots, which contributed an estimated 62 percent of the annual phosphorus loading to the lake. Very detailed lake and stream monitoring data has shown dramatic water quality improvements associated with the feedlot changes and a marked improvement in the algae blooms in this lake. See Exhibit A-4.

The reversibility of phosphorus loading into Minnesota's lakes is quite variable and is dependent upon the type and size of watershed and lake and stream. Water quality was greatly improved during a period of three years in the shallow lake in Redwood County described above. However, when phosphorus attached to sediment settles to the bottom of many lakes, these nutrients can be recycled for decades or centuries and continually create eutrophication and dissolved oxygen problems. See Exhibit A-4.

The transport of phosphorus to waters from manure sources can be greatly reduced by containing runoff from outdoor animal holding areas; injecting or immediately incorporating manure when applying to land; avoiding excess manure application to soils high in phosphorus, especially where runoff to surface waters is likely; siting manure stockpiles properly; and preventing the intentional piping, pumping or dumping into water bodies. Thus, the agency finds a need to establish minimum requirements to reduce impacts from manure sources and to ensure a consistent program exists to protect the environment across Minnesota and to ensure management flexibility by the feedlot owner be retained.

Nitrogen

Elemental nitrogen is found in the air we breathe. However, nitrogen-based compounds often have negative impacts on human health and the environment. The improper management of manure may result in surface water and ground water impacts from the introduction of nitrogen compounds that could deplete oxygen needed by fish or plants or by changing forms that impact human health. The discussion that follows explains how nitrogen compounds have the potential for negative impacts on human health and the environment and the need for a regulatory approach that establishes minimum standards for proper management of manure. It is necessary to site, design, construct and operate feedlots in a manner to reduce or eliminate risks to human health and the environment from the manure produced at these facilities and used elsewhere.

The nitrogen in manure is mostly in the forms of organic nitrogen and ammonium. Ammonia easily volatilizes into the atmosphere when the manure is land applied or disturbed in any manner. Ammonia can contribute to odors and can be transported long distances before being re-deposited during precipitation events. Under the presence of oxygen, most of the nitrogen in manure will eventually convert to the nitrate form of nitrogen. This conversion to nitrate typically will occur when ammonium (active form of ammonia, which is a gas) moves into soil below a feedlot, manure storage area or land application site, or when diluted in surface waters. Varying amounts of nitrate and ammonium from manure will be converted to nitrogen gas and consequently be lost from the water. The remaining nitrogen can present environmental problems in either the ammonium or nitrate forms.

The feedlot rules are needed to manage manure in such a way as to prevent negative impacts from ammonium and nitrates. The following discussion explains why and how proper management of manure reduces the potential impacts associated with these nitrogen compounds.

Runoff to surface waters from areas of manure accumulation can cause ammonia concentrations to be high enough to be toxic to fish and other aquatic organisms. As the ammonia converts to nitrate, oxygen will be consumed, also affecting aquatic life. Ammonium concentrations in Minnesota lakes and streams are often less than 0.1 mg/l and rarely exceed 1 mg/l. See Exhibit A-5. Typical ammonium concentrations in manure range from 300 to 2000 mg/l.

Ammonium is the form of nitrogen that presents the greatest environmental risk associated with surface runoff from outdoor animal holding areas and excessive surface application of manure to fields. Ammonium is very mobile in most soil types due to its solubility in water and thus, ease of movement. Ammonium can also leach through poorly lined liquid manure storage systems into ground water, where it will typically convert to the nitrate form of nitrogen. Nitrate can have negative health impacts on humans and animals. Elevated ground-water ammonium concentrations have been found below a poorly-lined manure storage facilities.

Problems from ammonium can be minimized by containing open lot runoff; immediately incorporating manure into the soil when applying to land; and using a well-constructed liner for liquid manure storage systems. It is necessary that the agency provide the minimum standards for these activities in rule to provide the feedlot owner a good understanding of what the agency believes are needed to protect human health and the environment. It is needed to provide such consistency as often capital outlays are required by the feedlot owner and without this knowledge up front, the feedlot owner will be unable to make wise business decisions.

Most of the nitrate in Minnesota waters originates from cropland production, feedlots and septic systems. Studies completed by the agency and the Minnesota Department of Health in 1991 confirm this statement. See Exhibit A-8. Nitrate is of greatest concern when it leaches to ground water and enters drinking water supplies. Over 70 percent of Minnesota’s population obtain their drinking water from ground water supplies, either private or public wells. High levels of nitrate in drinking water supplies can cause methemoglobinemia (blue baby syndrome) in human infants. It is for this reason that a drinking water standard of 10 mg/l has been set for nitrate.

Infants less than three months of age are most susceptible to methemoglobinemia, although individual adults may display increased susceptibility due to various factors. This condition occurs when nitrate is reduced to nitrite in the stomach or oral cavity. Nitrite is absorbed in the bloodstream and converts hemoglobin to methemoglobin. Methemoglobin interferes with oxygen transport; therefore, decreasing the amount of oxygen available to the person. Afflicted infants develop a bluish to lavender color around the lips and extremities. Other symptoms are those related to oxygen deprivation, including breathing difficulties, central nervous system defects, cardiac disrythmias and circulatory failure. Death sometimes results.

Between 1945 and 1972, approximately 2000 cases of infant methemoglobinemia were reported in world literature. However, it often goes unreported or may be misdiagnosed. See Exhibit A-6. In Minnesota, no registry is maintained for methemoglobinemia cases. However, a study of the problem was conducted in the 1940's. Between 1947 and 1949, 146 cases of methemoglobinemia were documented in Minnesota, including 16 deaths. None of the cases resulted when the suspected drinking water source had less than 30 milligrams per liter (mg/l) nitrate-nitrogen. At least three documented cases of methemoglobinemia have been reported in the Midwest during the past two decades, with one fatality. See Exhibit A-6.

In addition to human health concerns, it must be noted that nitrates at high levels will also have detrimental impacts on livestock. Spontaneous abortions, stillborn piglets, and gastrointestinal disorders are also found in livestock having consumed large quantities of nitrate-contaminated water. See Exhibit A-6. Thus, a need exists to establish standards that protect the economic investment by feedlot owners.

Nitrate-contaminated ground water also causes loss of property value and results in large expenditures in water treatment systems. Nitrate entering Minnesota streams affects water quality in our oceans. Much of Minnesota ultimately drains into the Mississippi River. The Gulf of Mexico, which receives water from the Mississippi, has experienced an increasing problem from algae growth. A condition known as hypoxia has developed on over 7,000 square miles of the Gulf of Mexico. In this zone, dissolved oxygen has decreased to levels, which do not support shellfish and much other aquatic life. Minnesota contributes some of the nutrients that cause the hypoxia problem. See Exhibits A-1 and A-7.

Livestock and poultry in Minnesota produce an estimated 269,000 tons of nitrogen annually. This number is calculated based on the Department of Agriculture statistics on the number of animals, types of animals, and the nitrogen contained in each animal type's manure. Feedlots can contribute to ground water nitrate problems primarily when manure from feedlots is applied to cultivated lands, or when manure seeps through improperly constructed or maintained liquid manure storage systems. Other feedlot-related contributions to ground-water nitrate can include abandoned open lots or infiltration of runoff near stockpile sites and open lots.

Manure is applied to approximately 3 million acres of cropland in Minnesota and supplies roughly 15 percent of crop nitrogen needs throughout the state. It has been well established through research that excessive nitrogen rates, applied as manure or inorganic fertilizer, will result in nitrate leaching and potential movement to ground water. See Exhibit A-8. The fraction of nitrate from over-applied manure that will move to ground water depends on the soil physical, chemical and biological characteristics and the conditions present between the soil and the water table.

Several investigations in Minnesota have provided information about nitrate concentrations moving in soil water below the rooting zone in cropland. Other investigators have measured nitrate concentrations in shallow aquifers on the down-gradient edges of cropped fields. The studies show that nitrate-nitrogen concentrations leaching below the rooting zone of row crop production fields in Minnesota typically exceed 10 mg/l, even with best management practices implemented, and often are two to four times the 10 mg/l drinking water standard. See Exhibit A-9.

While it is difficult to keep ground water nitrate levels below 10 mg/l when growing row crops, no matter what the fertilizer source, the additional nitrogen applied above crop fertilizer needs increases the potential for elevated nitrate movement to ground water. Based on numerous studies conducted by the Minnesota Department of Agriculture examining nutrient budgets on over 64,000 corn acres, livestock producers have been typically applying 40 to 70 pounds per acre of excess nitrogen in the forms of commercial fertilizer and manure. See Exhibit A-10. The over-application of the manure itself was not the principle cause of the excessive nitrogen rates. The lack of taking the full nitrogen credit from manure and legumes and, therefore, not reducing subsequent commercial fertilizer application is the primary reason for over-application. See Exhibit A-10.

Nitrate leaching to ground water and tile line water from fields subjected to manure application can be reduced by taking full credit for the nitrogen in manure and from legumes grown during the previous year. Understanding nitrogen credits will also reduce phosphorus loading to ground water and other water bodies. The agency proposes to establish minimum standards for manure application and nitrogen management in the proposed rules. These standards are needed to ensure that proper nitrogen credits and application rates are incorporated into feedlot operations and are based on the current industry knowledge.

Soil and ground water monitoring studies conducted throughout the country have determined effects on ground water from earthen manure storage basins that were constructed without a minimum two-foot thick clay-liner or a synthetic liner material equivalent to this standard. Results from 42 such monitored basins reported in the literature show that most of these sites have some evidence of elevated nitrogen in ground water or soil water resulting from the manure storage systems. See Exhibit A-11. The degree of reported ground water contamination varies widely, ranging from very slight elevations in nitrate and/or ammonium concentrations to some sites with total nitrogen concentrations over 100 mg/l above background levels. No ground water contamination or only slight evidence of degradation was reported at about half of the monitored facilities, with the other half showing total nitrogen concentrations at least 10 mg/l above background. It is necessary to establish design and construction standards for liquid manure storage basins to protect ground water from impacts from seepage through the liner.

Biological Oxygen Demand

Microorganisms flourish on the increased food supply provided by organic matter in manure. This increase in microorganisms depletes the oxygen levels in receiving waters faster than it can be replaced. The depletion of oxygen can cause fish kills or alter the species of fish and other aquatic life. Animal manure and feedlot runoff sources have relatively high concentrations of oxygen-depleting substances. Typical oxygen-depleting properties of various substances are listed in Table 3:

Table 3. Comparison of Oxygen-Depleting Properties of Waters, Sewage and Manure.

Source	Oxygen Demand (mg/l)
Stream water	2
Municipal sewage (treated)	25
Municipal sewage (untreated)	250
Cattle feedlot runoff	1000
Milkhouse wastes	1,500
Cattle or hog manure	50,000

See Exhibit L-2.

Recently, collected manure-contaminated runoff from a field that received a heavy application of manures contained 2200 mg/l of biological oxygen demand (BOD). As this liquid flowed into a ditch, the concentration was 1800 mg/l BOD. Runoff from an adjacent field that did not receive manure had 5 mg/l BOD. At a different site, manure-contaminated runoff from a hay field had 360 mg/l BOD, whereas runoff from an adjacent hay field with no manure applied had 1.6 mg/l BOD. See Exhibit L-2. It is necessary to establish some minimum controls to protect the environment from runoff of manure directly or from fields where manure has been excessively applied.

The impact of BOD-contaminated runoff from manure can be prevented by containing runoff from outdoor animal holding areas; immediately incorporating manure when land spreading near surface waters; and preventing intentional piping, pumping and dumping of manure. To ensure that these measures are utilized across the state, minimum standards are needed in the feedlot rules.

Pathogens

Bacteria, viruses, protozoa, fungi, rickettsiae and helmintus can be transmitted from animal waste to humans. Over 32 potential diseases can be transmitted by animal manure, mostly through ingestion of manure-contaminated surface or ground water. See Exhibit L-2. Both humans and livestock can potentially be impacted from manure-associated pathogens. Most of the pathogenic organisms associated with animal waste can enter another animal only by ingestion; however, hookworm and larvae can enter through the skin.

Transmission of water-borne diseases from animal manure to humans is not common. Even though large numbers of animals have existed for years in Minnesota, there have been no known major water-borne disease outbreaks as a result of animal waste contamination in the state. Yet, reporting of waterborne disease outbreaks is voluntary in the United States, and it is likely that waterborne diseases are under-recognized and under-reported.

Cryptosporidium, a protozoa commonly found in human and animal waste, has been responsible for numerous diseases outbreaks in the United States. In 1993, this organism caused the largest disease outbreak in U.S. history, resulting in 403,000 Milwaukee, Wisconsin, residents contracting watery diarrhea. Nearly 100 people died from this outbreak. See Exhibit L-2. Three to four other cryptosporidium outbreaks in municipal water supply systems have occurred in areas where livestock manure was a potential source of the problem. Cryptosporidium is very difficult to detect and very difficult to remove in water treatment systems.

Giardia is another parasite in animal manure that can be transmitted to manure. Giardia is now more easily detected in treated or public water supply systems. Several bacteria species found in manure can cause diarrhea in humans. Many other diseases can be transmitted from bacteria in manure, including septicemia, toxemia, meningitis, kidney infection, jaundice, Johne's disease and others. Bacteria can live from days to hundreds of days in the soil and water environment.

The occurrence of pathogens in the soil and water environment is rarely measured directly. Their presence is typically indicated by the measurement of indicator organisms such as coliform bacteria. The presence of fecal coliform does not necessarily imply that pathogens are also present; however, it does indicate that animal or human fecal contamination is present in the water. Fecal coliform organisms in feedlot and manure application site runoff typically number several million per 100 milliliters (ml) of sample. A small amount of manure contaminated runoff can result in exceedances of bacteria water standards, which are 200 MPN per 100 ml for most lakes and streams in Minnesota. The term, MPN, means most probable number and is a statistical means of reflecting the presence of bacteria. Elevated bacteria counts are a common reason for impaired surface waters in Minnesota. See Exhibit A-1. Most bacterial contaminants are not highly persistent and if placed in the sunlight will die fairly rapidly. See Exhibit L-2.

The number of people drinking water with pathogens originating from livestock manure is unknown. The most susceptible water supplies include all farm wells constructed prior to about 1974, wells in the uppermost aquifers in karst areas, and municipalities that rely on surface water for some or all of their drinking water. Swimmers and other water contact recreationalists also can be exposed to pathogen consumption. It is necessary to establish design, construction, and operational standards to protect surface water from the direct discharge of manure or manure-contaminated runoff. The minimum standards are needed in rule to ensure that all Minnesotans are afforded the same level of protection.

A very comprehensive and recent review of the effects of animal agriculture on water quality is included in the "Generic environmental Impact Statement on Animal Agriculture: A summary of the literature related to the effects of Animal Agriculture on Water Resources," and abbreviated "GEIS." See Exhibit A-1. The summary statements based on the literature review support the information previously presented in this document. For example, some of the conclusions presented in the Executive Summary are listed below. See Exhibit A-1, pages G-1 to G-13.

- "Livestock waste can contribute significantly to phosphorus loads in surface waters (seven to 65 percent of total loads);"
- "Feedlot runoff contains extremely large loads of nutrients and oxygen demanding substances, and if not properly collected and prevented from entering surface waters, this runoff can severely degrade surface water quality;"
- "Fecal bacteria in surface waters from lands receiving fresh manure applications can be a significant proportion (over 80 percent) of the fecal bacteria carried in surface waters" and
- "Nutrient losses in runoff from manured or fertilized fields are typically much greater than losses from unmanured or unfertilized plots."

Gaseous Compounds

Reduced sulfur, ammonia, and many other gasses are emitted from manure and can potentially affect human health. The sensitivity of people to these gases varies greatly. It is important to recognize the distinction between odor intensity and gas concentration. Odor intensity is a measure of detection sensed by the nose. Gas concentration is the actual concentration of the gas in the air. Studies estimate that between 80 and 200 gases are produced from decomposing livestock manure. See Exhibit A-12. A broad range of compounds has been identified in livestock manure, including volatile organic acids, alcohols, aldehydes, amines, fixed gases, carbonyls, esters, sulfides, disulfides, mercaptans, and nitrogen hetrocycles. The nose in very low concentrations (hydrogen sulfide) can detect some of these gases and others cannot be detected even at very high concentrations (methane). Gases are transmitted via air currents and can travel several miles or several feet, depending on the specific conditions.

Studies have established that there is a dose/response relationship for gases such as ammonia and hydrogen sulfide on human health (i.e., a particular concentration of gas for a particular amount of time will elicit a certain human response). These relationships are often not related to odor intensity. The dose/response relationship to most of the gases given off during manure decomposition has not been well documented or researched.

Feedlot odors may alter a person's mood. However, it is unclear if the mood altering impact is a psychological or physiological response to odor. Recent monitoring of hydrogen sulfide near Minnesota swine operations has occasionally shown levels that exceed health standards. Nausea, headaches, eye irritation, throat and respiratory irritation may result from short-term exposure to elevated levels of hydrogen sulfide. Short-term exposure is not believed to have any lasting health effects. Short-term exposure is defined as less than 8 consecutive hours over a 24-hour period at the health standard. See Exhibit A-12.

Other possible health problems associated with manure odors and gases include vomiting, shallow breathing, modified olfactory function, coughing, sleep disturbances and loss of appetite. Workers at the livestock facility or neighbors near the facility may be exposed to the feedlot gases and potential health risks. However, there is little documented information available concerning the health effects on either workers or neighbors.

A very comprehensive and recent review of the effects of animal agriculture on air quality is included in the GEIS. Some of the conclusions listed in the Executive Summary are included below. See Exhibit A-1, pages H-1 to H-2.

- "Animal agriculture can be a source of numerous airborne contaminants, including gases, odor, dust, microbes, and insects."
- "The rate of generation of these gases, organisms, and particulates varies with time, species, housing, manure handling system, feed type, and management system used, thus making prediction of contaminant presence and concentrations extremely difficult."
- "The environment and health effects of these ambient air contaminants on people, animals and the environment surrounding animal production sites is only beginning to be investigated. In some areas some or all of the emission contaminants have created environmental or health concerns, but long term impacts on ecological systems and people are not known."

The need clearly exists to establish standards for the design, construction, and operations of animal feedlots and manure storage areas such that the negative impacts of gases generated at these facilities are minimized, particularly past the property line of a facility. It is also necessary to provide feedlot owners information on when and how specific standards will be applied (i.e., hydrogen sulfide).

D. Specific Needs Supporting Amendments to the Existing Rules.

The MPCA is required by statute to protect the state's environment from pollution, including pollution from animal feedlots. The Legislative Auditor's Report of 1999 provides a summary of many of the potential concerns associated with animal manure. See Exhibit G-1.

Minn. R. ch. 7020, under the current language, establishes the process for reviewing and issuing interim permits and Certificates of Compliance for the agency and delegated counties. Minn. R. ch. 7020 was last revised in 1978. The Legislative Auditor's Report of 1999 points out some of the weaknesses of the current rule. See Exhibit G-1. In part, these weaknesses include:

- "MPCA's current rules on the responsibilities of delegated counties are vague;"
- "current rules do not directly address siting feedlot issues such as whether new construction or expansion should be allowed in environmentally sensitive locations;" and
- "without adequate rules, many of the regulatory restrictions placed on feedlots appear in certificates of compliance where their enforceability may be in doubt."

The proposed rules are intended to address these and many other identified deficiencies in the feedlot rules and program.

The agency has identified the three high priority areas where feedlots pose significant water quality challenges. The technical standards in the proposed feedlot rules primarily focus on these challenges. The three priority challenges are:

- Improper manure management for nutrients and over application of manure;
- Manure runoff from open-lot feedlots; and
- Improper siting, design, and construction of new and expanding facilities.

The other portions of the revised rules provide the administrative support to meet the technical standards.

Nutrients in the manure from Minnesota's livestock and poultry could supply about one-quarter of the nutrients needed for the state's crop production. Many large and small-operation livestock producers don't take enough credit for these manure-related nutrients in their nutrient planning efforts. Because of this, producers often apply excess commercial fertilizer to cropland that has already received manure nutrients. This over-application can cause nutrients to leach to ground water or be washed off to nearby lakes, streams and rivers.

Many open-lot feedlots have mild-to-severe problems with runoff of manure into surface waters. There is an environmental need to address these chronic problems. The environmental problems due to improper manure management or storage have not been solved by traditional regulatory methods, especially for the smaller existing open-lot facilities.

These older, smaller facilities are frequently greater sources of pollution from runoff than newer, larger facilities, where animals are kept inside. Installation of pollution-abatement can be very expensive for smaller operations; costing up to $100,000 for some operations with limited options. On the other hand, some operations may only experience the cost of moving a fence and re-seeding a buffer area along a stream or wetland ($3,000 per site depending on the length of fence). The agency anticipates, however, that the majority of smaller operations will spend $36,000 per site to comply with the requirements of the proposed rules. See the discussion of the estimated costs in the Section V of this SONAR.

To provide some financial relief, the proposed rules allow the owner of a small animal feedlot or manure storage area (fewer than 300 animal units) until 2009 to come into complete compliance with the effluent limitations. The agency is proposing this extended compliance schedule under part 7020.2003 as a tool for owners to address the problem of runoff from small feedlots, and the related cost to comply with the standards. In the past, permits were not issued because the problem could not be fully solved by the owners within the 10-month period for an interim permit, and governmental permitting systems would be quickly overwhelmed by the prospect of issuing 8,000 individual permits. Interim permits often required an extension to complete the project.

The three primary goals of the amendments to the feedlot rules are to:

- Make progress in the short-term by owners making the quick and low cost changes as soon as possible even though full compliance is not achieved;

- Provide more time for owners to completely fix problems than previously allowed so funding can be acquired and the changes do not interrupt facility operations; and
- Establish an interim and ultimately an end date for existing pollution problems to be resolved so that compliance is finally achieved.

Those facilities that are eligible for the extended compliance schedule and are proposing an expansion will be required to come into complete compliance with the effluent limitations prior to stocking the expanded site with livestock. The agency staff estimates that the majority of the feedlots eligible for the extended compliance schedule will take advantage of this relief mechanism.

The proposed rules do require the owner to achieve compliance with the standards in steps. A partial solution, which is intended to reduce the runoff by 50 percent, must be implemented by October 1, 2003. This first step can be accomplished through the installation of clean water diversions and buffer zones, which are relatively inexpensive pollution abatement methods (see the discussion of the estimated costs in the Section V of this SONAR). The second, and final, step is to bring the animal feedlot or manure storage area into compliance with the effluent limitations by October 1, 2009. This may be accomplished through the installation of a settling basins and adequately sized filter strip, and additional water diversions or the installation of a manure storage area (also see the discussion of the estimated costs in the Section V of this SONAR).

We can avert pollution problems in the future by ensuring that new and expanding facilities are built to specifications that prevent pollution problems in the first place. The proposed rules codify the requirements that the agency has inserted in individual permits in recent years. By putting these requirements in rule, owners will have an easier time identifying the minimum requirements for construction prior to submitting a permit application. This will save the owner, counties, and the agency time and money, and will better protect the environment. Besides specifying pollution controls in the siting, design and construction of new facilities, the MPCA also offers technical assistance to help farmers meet those specifications.

In addition to addressing the high priority environmental problems presented by feedlots, the goals of the proposed rules and the redesigned feedlot program are to:

- Focus on animal feedlots and manure storage areas that have a greater impact on water quality;
- Expand the role of delegated counties in feedlot regulation;
- Increase agency and delegated county field presence; and
- Make the feedlot program compatible with existing agency and county resources.

These goals are more specifically addressed in the statement of reasonableness.

IV. STATEMENT OF REASONABLENESS

Minn. Stat. ch. 14 requires the MPCA to explain the facts establishing the reasonableness of the proposed rules. "Reasonableness" means that there is a rational basis for the MPCA's proposed action. The reasonableness of the proposed rules is explained in this section. Section IV is broken into two parts: the reasonableness as a whole and the reasonableness of individual rule parts.

A. Reasonableness of the Proposed Rules as a Whole

The reasonableness portion of this SONAR provides the discussion and background on why and how certain provisions of the proposed rules were established. Specific requirements are not found under this part of the discussion but rather under part B. This Reasonableness of the Rules as a Whole deals with the mandatory requirements established by the Administrative Procedures Act in completing the SONAR. Minn. Stat. § 14.131 requires the agency to address the following issues.

1. **Describe the classes of persons who probably will be affected by the proposed rule, including classes that will bear the costs of the proposed rule and classes that will benefit from the proposed rule.**

The classes of persons most likely be affected by this rule include owners and operators of animal feedlots; persons involved in the storage, transportation, disposal and utilization of manure; those interested in management of domesticated animals or related facilities; delegated counties, counties interested in applying for delegation to implement a feedlot program; and those interested in Minnesota water quality.

Technical requirements impact more than just the owners and operators of animal feedlots, manure storage areas, and pastures. These requirements may also apply to those persons who haul and apply the manure as well as the owners of the land to which the manure is applied. The agency is proposing technical requirements under parts 7020.2000 to 7020.2225. The cost implications of these proposed requirements are discussed in the Consideration of Economic Factors under Section V of this SONAR.

Agency staff anticipates all parties in the state will be benefit from the implementation of these proposed rule revisions. The goals of the proposed rules are to establish a more efficient regulatory process; a closer county/state working relationship; and on-going guidance and support to animal feedlot, manure storage, and pasture owners, operators and technicians for the purpose of improving or protecting water quality in the state.

2. **Estimate the probable costs to the MPCA and other agencies of implementing and enforcing the proposed rule and any anticipated effect of the rule on state revenues.**

This discussion is located under the Consideration of Economic Factors, in Section V of this SONAR.

3. **Discuss whether there are less costly or less intrusive methods of achieving the purpose of the proposed rule.**

In developing the proposed rules, one of the focal points for agency staff was to develop a new permitting program that would, minimize costs to the state, delegated counties, and persons to which the rules apply. This goal had to be balanced with the need to address the requirement by the Legislature to issue National Pollutant Discharge Elimination System (NPDES) permits to animal feedlots with 1,000 or more animal units by the year 2004; the need to improve the environmental performance of a large number of small animal feedlots and manure storage areas (those with fewer than 300 animal units); and the need to provide ample opportunity for public input into the process of regulating animal feedlots and manure storage areas.

The agency is proposing several provisions intended to reduce the cost of compliance with the feedlot rules. The agency is proposing that animal feedlots or manure storage areas with fewer than 300 animal units are not required to apply for a permit unless that facility does not request the extended compliance schedule and has been determined to be a pollution hazard. The construction short-form permit is proposed as a method to make permitting for construction or expansion of facilities with 300 to 999 animal units more streamlined and less intrusive. In addition, the agency plans to establish general permits for those that are required to get a NPDES permit but are part of a group having similar regulatory issues. Thus, the agency will take advantage of a streamlined permitting process.

Experience with the existing regulatory program has shown staff that working with delegated counties also makes the permitting process less intrusive. Persons required to have permits are allowed to work closer to home with people more familiar with local concerns. The proposed rules expand delegated counties' ability to issue permits from facilities with fewer than 300 animal units to 999 animal units.

The guiding principal for the proposed permitting systems is to require the owner to apply for a permit only if the permit is required by federal regulations, or the permit will provide tangible benefits that cannot otherwise be achieved. For these reasons, the proposed rules require the owners of those facilities that:

- Meet the definition of concentrated animal feeding operation (CAFO) to apply for National Pollutant Discharge Elimination System (NPDES) permit;
- Are being constructed or expanded that have greatest the potential to be objectionable to local residents (construction or expansion of a facility that will hold 300 to 999 animal units after construction) to apply for a construction short-form permit; and
- The commissioner or county feedlot pollution control officer has determined that either the animal feedlot or manure storage area is a pollution hazard and must apply for an interim permit.

Facilities in the first group are required to obtain a permit under the federal regulations (40 CFR 122.23), and the agency has been delegated this permitting authority. Therefore, a permit is required by federal regulation and the agency is authorized to receive and process a permit application.

The second group of facilities is the new or expanding facilities. As discussed below, the construction of these facilities can be adequately regulated through rule. However, regulating construction at these facilities by rule eliminates an important opportunity for people interested in a facility to review the facility plans; to raise concerns; and to request from the agency a hearing on that facility. Animal feedlots and manure storage areas with 300 or more animal units are likely facilities to draw the most frequent criticism from local residents. The opportunity for local residents to consider the potential impacts of the construction or expansion of these facilities was an opportunity that the agency believed was worth preserving. Therefore, the notification establishes a route by which local governments or residents may raise concerns through local ordinances or perhaps the request for an Environmental Assessment Worksheet.

The agency considered requiring construction short-form permits for those animal feedlots or manure storage areas with 50 to 299 animal units. This was rejected for the following reasons:

- The state has an estimated 32,000 animal feedlots. The workload to issue permits for this group would shift staff resources away from the more valuable task of feedlot in-the-field oversight;
- The proposed rule establishes construction standards and notification requirements that would be required in the vast majority of construction permits issued to this group. Therefore, anyone interested in the requirements for construction of a facility of this size can see them at any time, especially prior to construction of the facility. An interested person would be able to request a copy from the project proposer. The small portion of owners that would propose to construct a facility different than allowed under the proposed rule will be required to obtain a state disposal system (SDS) permit. The SDS permit would require a public notice and comment period;
- The proposed rules still require agency, or county feedlot pollution control officer and local government notification of any construction including that at animal feedlots or manure storage areas with fewer than 300 animal units.

The agency did identify two factors that would support requiring animal feedlots and manure storage areas with fewer than 300 animal units to apply for a construction short-form permit. These factors are:

- Any animal feedlot or manure storage area has the potential to be objectionable to local residents and, if the proposed rules required the owner to apply for a permit, local residents would have one more opportunity to object to the construction or expansion of the facility. However, these facilities are more generally viewed as the small operators and have not drawn the criticism of the larger operations. The proposed rules do require the owner to notify all local governing bodies.
- Some county feedlot pollution control officers (CFOs) like the idea of requiring a construction permit for the construction or expansion of any animal feedlot or manure storage area with 50 or more animal units. The participation of delegated counties in the

proposed animal feedlot program is critical to the success of the program. Thus, the agency sees the opinions of the CFOs as very important. The agency believes that the primary argument for issuing permits to this small size facility is opportunity it provides for contact between the owner and the CFO. Since the proposed rule requires notification of the CFO prior to construction, the agency believes that opportunity for contact and discussion is preserved.

After considering the arguments for and against the construction short-form permit, the agency concluded that the additional cost of requiring construction short-form permits from animal feedlots and manure storage areas with fewer than 300 animal units was not justified. Thus, the agency did not include this requirement in the proposed rule.

The third group of facilities is the group that has been identified as those with existing or potential pollution hazards that must be corrected. A facility in this group is required to apply for a permit to give the agency or delegated county the opportunity to match a particular environmental problem with the appropriate fix. The fix to the environmental problem could also be accomplished through an enforcement action. However, the interim permit provides a mechanism for the agency or delegated county to get the environmental problem addressed in a much shorter period of time than could be achieved through the agency or county attorney pursuing an enforcement action. The cost (financial and administrative) to the agency or delegated county and the owner would be also much lower using interim permits than the cost of an enforcement action. The agency will, however, retain the ability to use enforcement actions instead of an interim permit depending on the particular situation.

Using the above-stated guiding principle of requiring an individual permit in limited and justified situations, the agency believes that the cost to owners, delegated counties and the agency to regulate all animal feedlots and manure storage areas in Minnesota has been minimized and the rules as proposed are reasonable.

4. **Describe any alternative methods of achieving the purpose of the proposed rule that the MPCA seriously considered and the reasons why they were rejected in favor of the proposed rule.**

As stated in the statement of need, the most efficient means to regulate a group of facilities is through individual permits for those that are unique, and cannot be regulated as a group, and general permits or permit-by-rule for the vast majority of facilities that have similar characteristics.

The agency considered requiring each owner having an animal feedlot or manure storage area to apply for a permit. However, the administrative cost to issue an estimated 40,000 permits does not provide a reasonable payback in terms of enforceability of the requirements.

The agency also consider no permits for any animal feedlot or manure storage area other than those required to obtain a permit under federal regulations. While the enforceability of requirements found in rule is the same as that of permits conditions, the opportunity for meaningful review and comment on the part of interested parties to a project are significantly reduced under such a program. The proposed rules require construction short-form permits for facilities that will have 300 or more animal units after construction for this reason. The agency believes that facilities under this size are those to which there will be the least objections. The proposed permitting system makes the best use of staff resources because permits are required for each facility only when the permit will meet a specific goal or accomplish a needed activity. No permit is required for any facility for which no justification exists.

5. Estimate the probable costs of complying with the proposed rule.

The probable costs of complying with the proposed rules are discussed in the Consideration of Economic Factors under Section V of this SONAR.

6. Provide an assessment of any differences between the proposed rule and existing federal regulations and a specific analysis of the need for and reasonableness of each difference.

The proposed rule has been developed with great consideration of federal regulations governing animal feeding operations (AFO) and concentrated animal feeding operations (CAFO) and all provisions proposed in this rule are intended to meet or exceed the federal regulations. The proposed rule is also consistent with many of the performance expectations for AFOs identified in the joint Environmental Protection Agency (EPA) and United States Department of Agriculture's (USDA) Unified National AFO Strategy (Strategy). See Exhibit G-2. Many provisions of the proposed rule also place AFO owners in a position to develop and implement a Comprehensive Nutrient Management Plan (CNMP), as the National Strategy suggests. However, the proposed rules, which establish criteria for the development of a manure management plan, allow more flexibility regarding who prepares the manure management plan and its content. These rule provisions include manure storage and handling requirements, land application of manure requirements, record keeping and other utilization options such as composting manure.

While there are several differences between the proposed rule and the existing federal regulations, many of these differences also exist today under the current state feedlot program. This Section, first, provides a brief description of the relevant federal regulations. Second, the Section provides a discussion of the general differences between the federal regulations and the proposed state regulations. Finally, a more detailed discussion of the following specific differences is provided:

- Definition of CAFO;
- Animal unit values;
- Federal effluent limitations versus state discharge standards;
- Case-by-case designation as a CAFO versus pollution hazard; and
- State technical standards for design, construction and operation

The Clean Water Act (CWA) establishes requirements for the discharge of pollutants from point sources. See Exhibit P-1. The federal regulations governing animal feeding operations are established in 40 CFR 122.23 and 40 CFR 122, Appendix B. See Exhibit A-14. Within the federal system, any discharge of animal manure or process wastewaters from CAFOs is prohibited, except in accordance with a National Pollutant Disposal Elimination System (NPDES) permit. In addition, when chronic or catastrophic storm events cause a discharge from a facility designed, constructed and operated to hold the manure, process wastewater and runoff from a 25-year, 24-hour storm event and under the current EPA effluent guidelines for CAFOs, permitted discharges do not violate the CWA.

In addition, the owner of a CAFO is required to obtain an NPDES permit, if the owner's facility is included in one of the following categories:

- AFOs having more than the number of animals listed in 40 CFR 122 Appendix B(a) including facilities with more than 1,000 animal units (a description of how to calculate animal units is provided in Appendix B to 40 CFR 122);
- AFOs having more than the number of animals listed in 40 CFR 122 Appendix B(b) including facilities with more than 300 animal units that may or do discharge by one of the methods covered by the regulations at 40 CFR 122, Appendix B(6); or
- AFOs designated by the permitting authority as a CAFO on a case-by-case basis.

The agency is given and charged with powers and duties that include the adoption of rules to prevent, control or abate water pollution. The existing rules pertaining to animal feedlots, manure storage areas and pastures, which have been in effect for the past 20 years, are established and implemented under these powers and duties. The proposed rule can be divided into four main sections: a registration program; a permit program; a delegated county program; and technical standards. Within these four main sections, the agency estimates that rule regulates an estimated 40,000 facilities in the state compared to the estimated 840 facilities (approximately 800 facilities having over 1000 animal units and 40 facilities having under 1000 animal units) in the state that are subject to the CAFO permitting regulations at the federal level. The proposed rule regulates these 40,000 facilities, which are comprised of CAFOs, AFOs, manure storage areas and pastures; whereas, the federal regulations regulate only CAFOs. The existing agency rules currently cover the estimated 40,000 facilities in Minnesota and the proposed rules intend to regulate the facilities under a different approach, which includes less administrative burden and clearer performance measures.

The proposed rule establishes regulations for any person involved in the storage, transportation, disposal or utilization of animal manure, process wastewaters or process generated wastewaters. The agency's justification for the need and reasonableness of regulating this comprehensive list of operations and persons is the wide range of potential pollutants associated with these operations and high value Minnesotans place on the natural resources of the state. The basic purpose of the federal regulations is to create a minimum program addressing larger feedlot operations in the country that have, or pose a significant potential to have, a discrete discharge to surface waters. There is no way a one-size-fits-all national regulatory framework is expected to provide adequate environmental protection for the myriad of different feedlot situations existing in a diverse number of individual states. More details of this justification are given in sections of this SONAR dealing with specific need and reasonableness issues.

The registration and permitting programs within this proposed rule are designed to work directly with the technical standards for design, construction and operation. The state program proposes two distinctly different types of permits, operational permits (NPDES and State Disposal System) and non-operational permits (construction short form and the interim corrective action), whereas the federal regulations rely solely on NPDES operational permits. Since the agency is proposing non-operational permits for most facilities under 1000 animal units, the proposed rule provides a registration system and technical standards to require regular contact with the regulatory agency or county and to place ongoing operational requirements on facilities.

The following is a more detailed discussion on the specific differences between the federal regulations and the proposed state rule.

Definition of CAFO

There are a few differences in how Minn. R. ch. 7020 classifies those facilities that are CAFOs and, therefore, those facilities that are required to apply for and obtain an NPDES permit. First, the federal regulations basically define a CAFO as having *more than* 1000 animal units or *more than* 300 animal units and meeting at least one of two discharge criteria. The proposed rule requires all facilities having 1000 *or more* animal units to comply with the same discharge standards and permit application requirements as CAFOs. The rule also establishes an animal unit threshold at 300 animal units *or more*, to distinguish facilities for purposes of the permitting program and technical standards. This difference results in approximately 20 facilities (MPCA Agwaste database, November 18, 1999) that are currently permitted for exactly 1000 animal units and are considered CAFOs under the state program.

The difference in the universe of facilities permitted under the federal programs is due, in part, to Minnesota statutes. Minn. Stat. § 116.07, subd. 7c(a), requires the agency to issue NPDES permits for feedlot with 1000 animal units or more based on a specified schedule. The existing feedlot rules, Minn. R. pt. 7020.1600, subp. 2, item A, uses the “less than 1000 animal units” language, Minn. R. pt. 7020.1600, subp. 2, item B, uses “less than 300 animal units” and Minn. R. pt. 7020.1600, subp. 3, uses “smaller than 300 animal units” language, all of which are consistent with the proposed rule language. The provisions under 40 CFR 412.10 of the federal regulations also establish the subcategories of feedlots subject to applicable effluent standards. This federal provision establishes an equivalent capacity of “as large or larger than” 1000 animal units. Additionally, Minn. R. pt. 4410.4300, subp. 29, item A, deals with mandatory Environmental Assessment Worksheet (EAW) categories for animal feedlots and also uses the “1000 animal units or more” language. Finally, many counties, townships and cities in Minnesota currently have local ordinances that regulate animal feedlots and the ordinances use language consistent with the existing rules. Thus, the inclusion of facilities at exactly 1000 animal units under the proposed feedlot rules and different from the federal program is reasonable because it does not cause a significant shift in local government programs; impacts a relatively small number of facilities in the state, which most already consider their facilities to be subject to federal regulations; and the program has operated under this regulatory structure since at least 1979, when the rules were last revised.

Another potential difference exists because the proposed rule includes manure storage areas (where no animals exist) in the definition of CAFO. The federal regulations do not specifically include manure storage areas where no animals exist in the definition of CAFO. However, the EPA Guidance Manual and Example NPDES Permit for CAFOs, review Draft, August 6, 1999, describes in section 2.1 what an AFO is. See Exhibit P-2. The guidance states that "EPA defines the AFO to include the confinement area and the storage and handling areas necessary to support the operation (e.g., waste storage areas)." Therefore, the inclusion of manure storage areas having the capacity of 1000 animal units or more in the definition of CAFO is reasonable because a storage are capable of storing manure from 1000 animal units or more is a facility that is necessary to support an animal feeding operation.

The agency does not intend that a CAFO obtain two separate permits for the two distinct parts of the operation. The agency does intend, as does EPA, that one permit would cover the entire operation even if the parts are not adjacent. Furthermore, the agency intends that a manure storage area capable of storing manure from the equivalent of volume 1000 animal units or more from several non-CAFOs be defined as a CAFO. This is reasonable because the facility presents a comparable environmental risk as an animal holding area for 1000 or more animal units, given the presence of a comparable volume of manure. Such a facility would typically be a commercial manure management facility, and not only presents risks from the actual storage facility, but also from the loading of vehicles for transport to land application sites and unloading of manure from the original animal feedlot. Therefore, it is reasonable to treat these facilities similarly to the facility managing 1000 animal units of livestock.

An issue receiving considerable comment during this rulemaking is in federal regulations, 40 CFR 122 Appendix B, which reads in part as: "Provided, however, that no AFO is a CAFO as defined above if such AFO discharges only in the event of a 25-year, 24-hour storm event." Federal regulations require CAFOs to apply for an NPDES permit and Minnesota statute requires the agency to issue NPDES permits to the owners of all facilities having 1000 animal units or more. EPA's August 6, 1999, draft guidance document describes in section 2.3.6 that "Most AFOs with more than 1000 animal units probably have discharged in the past or have a reasonable likelihood to discharge in the future, at less than a 25-year, 24-hour storm event, and therefore are required to apply for and obtain a (NPDES) permit." See Exhibit P-2. This Section of the guidance document also provides that "Facilities that believe that they do not discharge should apply for an NPDES permit and provide documentation of no discharge with the permit application." The proposed rules provide for permit coverage under either scenario. If the facility meets the CAFO criteria, the facility will be issued a joint NPDES/SDS permit; if the facility does not meet the CAFO criteria but has 1000 animal units or more, the facility will be issued an SDS permit. It is reasonable to regulate both types of facilities similarly due to the risks associated with confining 1000 animal units in one area, whether the facility is a CAFO under federal regulations or not. The managing of livestock or poultry in numbers great enough to reach the 1000 animal unit have additional concerns regarding their construction, design and operation of whether that facility is subject to federal regulations because of the CWA issues regarding point source discharges. It is reasonable to use the permitting process to account for these risks.

A significant factor in determining the potential to discharge under the federal program is the consideration of stockpiling and the land application sites. EPA's draft guidance addresses this factor in two sections of the guidance document. See Exhibit P-2. Section 2.1 states that "discharges of CAFO wastes from land application areas can qualify as point source discharges in certain circumstances… Accordingly, CAFO permits should address land application of wastes from CAFOs." Section 2.3.2 states that "a poultry operation that conducts improper land application activities or stacks waste in this manner (in areas exposed to rainfall or adjacent to a watercourse) and that otherwise meets the CAFO definition …, is a CAFO and subject to the NPDES program." An EPA memorandum dated September 27, 1999, also addresses this issue by reiterating the guidance sections above and also stating that "More specifically, discharges of manure and wastewater from land application areas should be viewed as discharges from the CAFO itself, even though, as the draft guidance notes, the definition of an AFO describes the area of confined animals and does not mention land application areas." See Exhibit P-2. The agency's position on this issue is again, that any facility having 1000 animal units or more may be a CAFO under the federal program, which the agency is delegated to implement, because these is the potential to discharge where manure is produced, stored or land applied. This position is reasonable because it is consistent with the excerpts from EPA above, it provides a more consistent and certain position for facility owners, and owners have the opportunity to demonstrate that they are not a CAFO.

All facilities having 1000 animal units or more must apply for an NPDES permit under the proposed rule. If a facility in this category demonstrates through the permit application process or is determined through a process or guidance established by the federal government that it does not meet the definition of CAFO and thus, does not need an NPDES permit, the proposed rule requires that the facility apply for an SDS operating permit. The requirement for an SDS permit is reasonable because it establishes a similar set of standards for all facilities having 1000 or more animal units.

<u>Animal Unit Values</u>

Federal regulations provide criteria in 40 CFR 122, Appendix B for determining if an AFO is a CAFO. These criteria are based, in part, on: the number of animals in a category that are housed at a facility (nine animal categories are listed); or by the total number of animal units housed at a facility (animal unit multiplication factors are given for five animal types). The proposed rule part 7020.0300, subp. 5, includes animal unit multiplication factors for thirteen animal categories. Of these, five have state multiplication factors that are different than the corresponding federal categories or multiplication factors. In general, the proposed animal unit values in the proposed rule are intended to provide clarity and fill gaps in the federal animal-unit multiplication factors.

First, the animal-unit multiplication factor for mature dairy cattle (whether milked or dry cows) is given by federal regulations as 1.4. Federal regulations also have animal number thresholds set at 700 mature dairy cattle (within the group of 1000 animal unit facilities) and at 200 mature dairy cattle (within the group of 300 animal unit facilities). The state multiplication factor is set at 1.4 under the existing rules and is proposed to be separated into two factors, one for mature dairy cattle over 1000 pounds which will remain at 1.4 and one for mature dairy cattle under 1000 pounds which is proposed as 1.0 animal units. The reader is advised to read the explanation found in the specific reasonableness for part 7020.0300, subp. 5, items A and B, for a more detailed explanation on the determination of the state multiplication factor. The agency has selected a separate multiplication factor for a mature dairy cow over 1000 pounds and for a mature dairy cow weighing less than 1000 pounds. The agency believes specifying two separate factors for dairy cows is reasonable because those breeds tending to mature at lighter weights have been shown to produce less manure and therefore, the risk to human health and the environment would not be equivalent from 1000 animal units. Additionally, the separation of dairy cows based on mature weights allows agency and delegated counties to reconcile differing approaches to this issue. County concerns regarding the management aspects need to be heard as they are critical to the success of the proposed feedlot program as explained in this SONAR under part 7020.1600.

Another difference exists in the dairy cattle category. This difference is the agency's proposed addition of a second dairy cattle multiplication factor (part 7020.0300, subp. 5, item A, subitem (2) providing a lower weight criteria of 1000 pounds for the 1.4 factor, that may be viewed as being less restrictive than federal regulations for dairy cattle. As described in this SONAR for this definition, the agency has been provided with data that identify a significantly lower manure production rate for the Jersey cow breed compared to other milking breeds. See Exhibit P-5. The need and reasonableness of these proposed changes is discussed in more detail in this SONAR for part 7020.0300, subp. 5, item A.

Second, the animal-unit multiplication factor for slaughter steer and feeder cattle in the proposed rule includes heifers. This difference from the federal regulations is reasonable because it retains the heifer language that exists in the current state rule and clarifies a very common animal type. Minnesota feedlot owners raising heifers will not be under a different category of permit needed due to a change in animal units managed simply due to a rule change. The inclusion of heifers is consistent with the amount of manure generated by them and the other cattle types included in the category.

Third, the animal-unit multiplication factors for swine in the state program includes a value for swine under 55 pounds, which is not included in the federal regulations. Again, this difference from the federal regulations is reasonable because it retains language that exists in the current state rule and clarifies a very common animal type.

Fourth, federal regulations do not include a specific multiplication factor for poultry. However, the animal unit multiplication factors for chickens in the proposed rule are consistent with the factor one would obtain by interpreting the animal number categories in federal regulations (e.g., 1000 animal units divided by 100,000 broiler chickens equals 0.01). The existing state rule has been implemented to consider all chickens, regardless of size, as 0.01, which is both more restrictive and less restrictive than the federal regulations. The existing state value is more restrictive by including small chickens or pullets as 0.01 animal units that are not addressed by the federal regulations and are less restrictive for facilities with a liquid manure system that have a (interpreted) multiplication factor of 0.033. The proposed rule eliminates this less restrictive factor and provides a more reasonable factor of 0.003 for the smaller chickens by adding a weight threshold of 3 pounds. The reasonableness of this threshold is discussed in this sonar under part 7020.0300, subp. 5, item F. Providing a threshold any higher than 3 pounds creates too great a potential inconsistent interpretation of the rule. For example, if the threshold were set at five pounds and a facility has 100,000 broiler chickens that weigh up to five pounds each, the facility would be considered CAFO under the federal regulations while having only 300 calculated animal units under the state program and providing an argument that the facility is not a CAFO under the state program. Such a difference would create a risk to owners of poultry operations for being out of compliance with federal regulations. The agency believes that it is unreasonable to put feedlot owners at such a risk. Again, the provision is reasonable because the state program meets or exceeds the federal program, reduces risk to the feedlot owner, and fills the needed gaps to allow the agency and delegated counties to address manure produced at facilities of all sizes.

Finally, similar to the discussion above for chickens, federal regulations do not include a specific multiplication factor for turkeys. However, the animal-unit multiplication factors for turkeys in the proposed rule are consistent with the factor one would obtain by interpreting the animal number categories in federal regulations (e.g., 1000 animal units divided by 55,000 turkeys equals 0.018). The existing state rule has been implemented to consider all turkeys, regardless of size, as 0.018 animal units. The proposed rule retains this factor for the adult turkeys and adds a more reasonable factor of 0.005 for the smaller brooder turkeys (by adding a weight threshold of 5 pounds). The reasonableness of this threshold is discussed in this sonar under part 7020.0300, subp. 5, item G. These differences are, therefore, reasonable because the state program meets or exceeds the federal program and fills the needed gaps to allow the agency and delegated counties to address manure produced at facilities of all sizes.

Federal Effluent Limitations and State Discharge Standards

There are several differences between the federal discharge standards or effluent limitations and the proposed state discharge standards. The federal regulations require all CAFOs to meet the “no-discharge” standard (40 CFR 412.13), except that CAFOs discharging when chronic or catastrophic events cause an overflow from a NPDES-permitted facility designed, constructed, and operated to contain all process waste waters plus the runoff from the 25-year, 24-hour storm event do not violate the CWA. The state standards propose a three-tier approach for which the need and reasonableness is described in this SONAR under part 7020.2003. The three-tier state standards require that CAFOs and facilities with 1000 or more animal units must meet the federal regulations described above; that other facilities under 1000 animal units must comply with the effluent limitations in Minn. R. pt. 7050.0215; and that eligible open-lot facilities under 300 animal units must comply with Minn. R. pt. 7050.0215 through an extended schedule with interim improvements required by October 2003 and final measures completed by October 2009.

In all cases, the agency may require a facility to meet an effluent limitation more stringent than specified above to address such issues as total maximum daily loading (TMDL) requirements for a particular waterbody.

The federal regulations allow NPDES permits to address ground water only when a discharge of pollutants to surface waters can be proven to be via ground water. See Exhibit A-15. Under the existing and proposed state permitting programs, when issuing an NPDES permit, the agency will issue the owner a combination NPDES and State Disposal System (SDS) permit in the same document. It is needed and reasonable for the state to address both surface- and ground-water quality standards in a single permit for CAFOs so that comprehensive protection of state water resources occurs.

The referenced effluent limitations under Minn. R. pt. 7050.0215 requires owners not subject to the no-discharge standard under the federal regulations (40 CFR 412) to meet a 5-day biochemical oxygen demand (BOD) limit of 25 milligrams per liter (based on the arithmetic mean of all samples taken with a calendar month). If the facility also discharges to or affects a lake or reservoir the nutrient control requirements in Minn. R. pt. 7050.0211, subp. 1 also apply. However, federal regulations define facilities between 300 and 1000 animal units as CAFOs if they discharge by one of two methods including directly or through a man-made conveyance. Again, the state standards also regulate discharges to ground water for this group of facilities. If a non-CAFO between 300 and 1000 animal units can demonstrate compliance with Minn. R. pt. 7050.0215, then the facility may comply with the effluent limitations in accordance with Minn. R. pt. 7050.0215.

The third tier of the state discharge standards provides a compliance schedule for open-lot feedlots having fewer than 300 animal units. This provision of the rule has been designed to require the smaller open-lot feedlots (under 300 animal units) to comply with the same effluent limitation standard as the non-CAFO 300 to 1000 animal unit facilities, although this group is given an extended time period to achieve compliance. In part, the agency selected the October 1, 2009, final compliance date to be consistent with the joint EPA/USDA Strategy that identifies the year 2009 as the desired date for all AFOs to have developed and implemented a CNMP. See Exhibit G-2. It is reasonable for the state rules to address these smaller, high-risk facilities, even if federal rules do not cover these facilities. As stated before, federal regulations are primarily intended to focus on larger facilities but that does not mean that it is not reasonable for states to address additional risks associated with smaller facilities that may also impact both surface and ground water.

<u>Designation as a CAFO and designation as a pollution hazard</u>

Federal regulations provide for designation of any sized AFO as a CAFO on a case-by-case basis if the facility is a significant contributor of pollution (40 CFR 122.23(c)). Under the definition of CAFO, the agency has incorporated by reference the case-by-case designation process under 40 CFR 122.23 into the proposed rules. Similarly, the commissioner or delegated county feedlot officer may designate a non-CAFO facility as a pollution hazard if the facility meets one of two criteria (part 7020.0300, subp. 19a). Item B of the pollution hazard definition is very similar to the case-by-case designation criteria identified in federal regulations. However, the most significant differences are:

- The agency has removed the consideration of "other relevant factors" in the definition of pollution hazard to better distinguish the federal criteria from the state criteria;
- The agency's pollution hazard definition may also address pollution to ground water;
- County feedlot officers may use the pollution hazard definition to address problems; and
- The agency would not have the resources to address under an NPDES case-by-case designation process.

This is reasonable because the agency does not intend to issue require NPDES permits to all facilities with pollution hazards.

When implementing the case-by-case designation process and the pollution hazard process the agency intends to follow consistent procedures. In fact, the agency has a policy on implementing the federal case-by-case designation process for AFOs. See Exhibit P-3. This process is consistent with the federal process, and therefore, no differences exist in how the agency or EPA will designate a CAFO on a case-by-case basis.

Furthermore, the agency anticipates that when an animal feedlot, manure storage area, or pasture has been determined to be a significant pollution source, the agency will attempt to seek the owner's cooperation in obtaining a timely resolution and elimination of the pollution problem. This process may include issuance of an interim permit, a tool most frequently used by the agency or delegated county, if the matter can be resolved within a short time period. The process could also include the use of other tools such as notice of violation or other enforcement tools, such as an administrative penalty order. In any case, a variety of tools are available, including the NPDES permit if the facility is designated a CAFO. The differences in these processes are reasonable because the EPA and the agency have the same basic goal to eliminate the discharge as soon as possible. The agency's experience has been that most pollution problems at the smaller facilities can be corrected in a relatively short time frame. Often, the problems can be corrected faster than the agency could process and issue an NPDES permit. The process described above is reasonable because it significantly reduces the administrative resources needed to correct the problem by agency or delegated county issuance of an interim permit instead of an NPDES permit and allows ground water pollution hazards to be addressed under the state feedlot program.

<u>State Technical Standards for Design, Construction and Operation</u>

Parts 7020.2000 to 7020.2225 of the proposed rule establish standards for discharge, design, construction, operation and closure of animal feedlots, manure storage areas and pastures (technical standards). A subtle difference in the technical standards and federal regulations is that the federal regulations provide the effluent limitations with little direction on how to achieve compliance and the state proposes to establish technical standards to clarify its expectations of facility owners to achieve compliance.

However, many of these, or similar, specific technical requirement have been placed directly into NPDES permits issued by the agency for about the past six years. A second difference is in the state's overt protection of ground-water discharges through several of the specific technical standards including: discharge standards, part 7020.2003; location restrictions, part 7020.2005; closure, part 7020.2025; liquid manure storage areas (MSA), part 7020.2100; unpermitted MSAs, part 7020.2110; poultry barn floors, part 7020.2120; stockpiling, part 7020.2125; composting, part 7020.2150; and land application of manure, part 7020.2225. Again, the federal regulations do not address ground-water discharges and it is reasonable that the state rules provide a comprehensive protection framework, particularly, when it is understood that nearly 70 percent of Minnesota's population obtains its drinking water from ground water sources.

7. **Conformance to the requirements under Minn. stat. § 16A.1285 relating to review of the proposed rules by the Commissioner of Finance.**

As required by Minn. Stat. § 16A.1285, the Commissioner of Finance has reviewed the charges proposed in this rule. See Exhibit F-3. The Commissioner of Finance's comments and recommendations are attached. See Exhibit F-4. For additional discussion on this topic see the Consideration of Economic Factors, Section V of this SONAR.

8. **Describe how the agency, in developing the proposed rules, considered and implemented the legislative policy under Minn. Stat. § 14.002, which requires state agencies, whenever feasible, to develop rules and regulatory programs that emphasize superior achievement in meeting the agency's regulatory objectives and maximum flexibility for the regulated party and the agency in meeting those goals.**

The agency focused on providing maximum flexibility for the regulated parties in three main topic areas as follows:

<u>Providing opportunity for implementing construction and operation methods that differ from those required in the specific rule parts</u>

During the FMMAC meetings held from May to October 1999, the poultry industry representatives raised concern regarding proposed rule language that specified one construction method for soil-lined poultry barn floors. They raised the issue that a construction method or material other than what is stated in the rules could provide the same level of environmental protection. Since the agency is concerned about the environmental protection outcomes rather than establishing one construction method, the agency responded to this concern by providing construction option for concrete-lined, asphalt-lined or PVC-lined floors under part 7020.2120. It is reasonable to allow a facility owner options for meeting an environmental outcome to incorporate the final design option that matches the facility business plan.

Since the concept that the agency's environmental protection goals can be achieved through methods that are different than the construction or operation methods outlined under parts 7020.2000 to 7020.2225, the agency proposes to allow alternative methods as they are approved through the SDS permitting process. Since methods other than those specified in the rules must be evaluated to determine that they will achieve at least the same level of environmental protection as the rules, the agency is allowing these alternative methods to occur under the SDS permit process. See part 7020.0405, subp. 1, item B, subitem (3). The SDS permit process provides an extensive site-specific review and a public notice and comment period for the proposed permit. This process allows alternative methods other than those stated under the rules to address pollution issues and reach state pollution goals and opens the door to possible new technologies in the future without jeopardizing the established level of protection for the environment.

<u>Custom fitting annual goals for delegated county programs</u>

Currently, 51 counties have received delegation under Minn. R. pt. 7020.1600 for the processing of interim permits and certificates of compliance. Each of these counties is unique in the number of livestock operations and the types and number of environmentally-sensitive areas that are contained within its jurisdiction and the number of staff hired to manage the local program. These and other related characteristics determine what procedures and goals are achievable and effective for each delegated county.

Therefore, the agency wanted to design the county delegation program with the flexibility for counties to determine how best to use their resources and establish their own inspection and other programmatic goals to help the agency meet the state environmental goals for animal facilities. For this reason, the agency did not specify numeric annual inspection, permitting, registration, and complaint response or owner assistance goals. Instead, the agency is proposing to use a delegation agreement. The delegation agreement will allow the agency and county to establish annual goals through negotiation that are based on available resources and the work needed to achieve an effective program. The agency believes that it is reasonable to allow a county to evaluate its needs and resources when establishing a program to meet the environmental outcomes specified in the proposed rules. Under this management scheme, a county will not be required to expend more resources than appropriate to achieve the environmental results or that are beyond its capabilities.

<u>Establishing steps for achieving compliance with water quality discharge standards for smaller open-lot feedlots</u>

One of the greatest existing threats to Minnesota's waters is runoff from open lots at small animal feedlots. The current rules require that all animal feedlots and manure storage areas comply with the water quality discharge standards of Minn. R. pt. 7050.0215. Attaining this standard is out-of-reach for many of these facilities due to the cost to comply with the standard and the short period of time allowed, under the current Interim permit, to correct the runoff problem.

The agency have added flexibility into the proposed rules by establishing a stepped approach for achieving compliance with the water quality standards at open lots under Minn. R. pt. 7050.0215 for the owners of these small animal feedlots (fewer than 300 animal units). See part 7020.2003, subp. 4, for proposed eligibility requirements. The agency proposes to allow these facility owners until October 1, 2009 to come into compliance with Minn. R. pt. 7050.0215 for the open lot portion of the facility. However, these owners must install and operate a system of clean water diversions (diversion to keep uncontaminated runoff from running across an open lot and becoming contaminated prior to entering waters of the state) prior to October 1, 2003. The intent of requiring owners to install the diversions is to achieve a reduction in the quantity of pollutants entering waters of the state by at least 50 percent by October 1, 2003. A 50 percent reduction in runoff will have a measurable impact on the water quality of Minnesota. The proposed rules allow the owners time to arrange financing, and potentially a subsidy, for the installation of the manure storage area and/or runoff filtering area before complying with the water quality discharge standards under Minn. R. pt. 7050.0215 for the open lots.

9. **Describe the agency's effort to provide additional notification to persons or classes of persons who may be affected by the proposed rule.**

The agency's efforts to provide additional notification to persons or classes of persons who may be affected by the proposed rule are discussed in the Additional Notice Section VI of this SONAR.

B. Reasonableness of the Rules Related to the Goals of the Feedlot Program Plan

The proposed rule is intended to address ground-water and surface-water quality protection issues resulting from animal feedlots, manure storage areas, and pastures. The proposed rule consists of essentially four parts that deal with the following: registration, permitting in general, county feedlot programs and technical standards (standards for discharge, design, construction, operation and closure). Each of these parts is required to achieve the goals established for the proposed rules. Air emissions from animal feedlots and manure storage areas are considered to the extent directed by the Governor in his legislation veto letter to Speaker Sviggum dated May 25, 1999. See Exhibit G-4.

The MPCA's broad goals for revising the rules at this time include the need to:

- Focus on animal feedlots, manure storage areas and pastures that have a greater impact on water quality;
- Expand the role of delegated counties in feedlot regulation;
- Increase agency and delegated county field presence;
- Achievable with existing agency and county resources.

Focus on facilities that have a higher impact on water quality

Not all animal feedlots, manure storage areas, and pastures have the same water quality impact or the potential for water quality impact. As a group, small open lots with runoff present one of the greatest threats to water quality in Minnesota. It is estimated that 8,000 to 12,000 of the 40,000 or so feedlots in the state have fewer than 300 animal units and significant runoff from an open lot. This runoff pollutes innumerable rivers, lakes and streams that result in waters that cannot support life other than vegetation and some rough fish.

Large animal feedlots and manure storage areas with more than 1,000 animal units individually present the greatest potential for significant water quality impact in the event of a significant failure such as failure of a liquid manure storage area. For this reason alone, it is necessary to closely monitor these facilities.

In addition to focusing the agency's attention on the two previously mentioned groups, the proposed rules address technical issues that confront all animal feedlots, manure storage areas, and pastures including the establishment of clear:

- Statewide expectations for manure storage, handling and land application or utilization;
- Design and construction requirements;
- Operation requirements; and
- Manure and nutrient management requirements.

The agency is charged with the responsibility to protect human health and the environment for Minnesota. Therefore, it is reasonable to focus the agency's resources on those feedlots presenting the greatest potential for impact.

Expand the roles and responsibilities of delegated counties in feedlot regulation

The agency recognizes the vital role that delegated counties have played in effectively regulating animal feedlots, manure storage areas, and pastures in the past and the even more important role these counties will play in the future. The method of regulating feedlots under the proposed rules would undergo a dramatic realignment of resources from staff dedicated to issuing permits to staff in the field interacting with owners. This shift has been termed as a movement to field presence. Field presence is best described as communication between the owner and agency and/or delegated county staff at the facility. This communication will include a continuum that ranges from educating owners of the requirements of the rule and suggesting ways in which to achieve environmental performance at the facility to inspections and enforcement action for violations of the rule requirements. The proposed rules include provisions intended to increase the field presence by increasing the number of delegated counties. The number of delegated counties should increase under the proposed rules by addressing the concerns that the agency has heard as reasons for counties not to seek delegation. The proposed rule would:

- Increase the number of feedlots for which delegated counties can issue permits;
- Clarify the roles and duties of the delegated counties and the Agency; and
- Increase county share of administrative responsibility of the feedlot program.

It is reasonable to provide delegated counties more responsibility for implementing the feedlot program because they know the local geologic conditions and environmentally-sensitive areas that could be negatively impacted by feedlots. Additionally, the increased permitting authority to counties allows them to coordinate local land use issues more effectively and efficiently. It is also reasonable to spend the agency's resources by meeting with facility owners at the site rather than issuing permits from an office as it allows for site specific conditions and management options to be incorporated in the owners methods to achieve an environmental outcome. Each feedlot is unique with specific factors that must be addressed in efforts to protect the environment.

Increase agency and delegated county field presence

As stated above, the proposed rules represent a dramatic shift in the allocation of staff toward an emphasis on field presence. This strategy is based on the belief that the greatest environmental gains can be realized through education and compliance verification. This is best accomplished through direct contact between the agency and county staff and livestock producers. Given the desire to achieve this field presence without significantly increasing the number of staff working on feedlots, it is necessary to devise a program that allows the reallocation of the existing staff. Changes in the proposed rules regarding permit procedures and the universe of facilities to be permitted are reasonable as they allow this reallocation of staff by significantly reducing or eliminating the need for permits by providing clear rule technical requirements.

Clear technical requirements allow the agency to adopt a regulatory system that is not entirely dependent on permits to effectively regulate a large number of facilities. Most regulated groups can be divided into two groups: one that has relatively few members that have unique characteristics or concerns; and the second, much larger group, whose members are very similar with the same or similar characteristics and concerns. The most efficient means to regulate a large number of similar facilities is through clear rules. Rules and permits carry the same legal weight with regard to enforcing conditions to which a facility is subject. The animal feedlots, manure storage areas, and pastures in Minnesota all have similar issues, or at least a very small number of different issues, with regard to manure storage area construction, and manure management. For this reason, the proposed rules contain clear detailed technical requirements for the following:

- Locating animal feedlots and manure storage areas;
- Transportation of manure;
- Livestock access to water;
- Milkhouse waste;
- Animal feedlot and manure storage area closure;
- Non-certified/unpermitted manure storage areas;
- Poultry barns floors;
- Manure stockpiling;
- Manure composting; and
- Land application of manure.

By including these parts in the proposed rules and making them broadly applicable, the need to issue permits to each feedlot is significantly reduced and the time required to draft any individual permit is significantly reduced because these requirements (if deemed adequate by the agency) can be referenced in the draft permit instead of negotiated individually with the owner. This is a reasonable outcome of the rules as the window of opportunity for expanding or entering the livestock or poultry market can be very small and administrative delays can have serious economic impacts.

The proposed rules do not require permits for facilities, with fewer than 1,000 animal units that are in compliance with the proposed technical standards; are not constructing or expanding; and are not determined to be a pollution hazard. A pollution hazard, under the proposed rules, can only be determined by a site inspection by the agency or delegated county. Thus, a feedlot owner will not face expenditures not related to a real environmental need. The proposed rules also do not require owners to apply for a construction permit if the facility will have fewer than 300 animal units; if the facility is in compliance with the technical standards; and if the facility owner will construct and operate the facility or expansion in compliance with these standards. Potentially lost in a system of regulation not dependent on permits for each facility is the opportunity for public notification and input on a specific project. The proposed rules address this potential problem by publishing in the rules the technical conditions that would be included in an individual permit if one were to be issued, and by requiring notification in a local paper for any construction project that will increase the capacity of the facility and local government notification for construction or expansion of animal feedlots or manure storage areas with 500 or more animal units. The latter notification is intended to address and clarify the notification requirements under Minn. Stat. § 116.07, subd. 7a.

Because the need to issue permits has been significantly reduced by including clear technical standards in the rule, the staff resources that were previously dedicated to the permitting activity can be reallocated, in the future, to activities that increases the field presence. The proposed regulatory system will produce superior environmental performance (improved water quality) with a lower administrative burden and the fewer staff than would be required achieve similar environmental results under the existing permitting system. The agency believes that is prudent public policy and a reasonable use of resources to match desired environmental outcomes and the potential risks associated with a facility to the administrative requirements.

Achievable with existing agency and county resources

A goal of the proposed rule revisions has been to achieve superior environmental results with the existing state and county staff resources. The program plan is largely based on the goal of increased field presence. See Exhibit I-4. That is what staffing level would it take to visit and inspect each of the approximately 40,000 animal feedlots and manure storage areas in Minnesota within 10 years of the effective date of the rule. The program plan also includes the estimated staffing level to effectively oversee the county feedlot programs; issue NPDES, SDS, construction short-form and interim permits; provide training to feedlot and manure storage area owners and county feedlot pollution control officers; review manure management plans, and all of the other requirements of the proposed rules. Currently, the feedlot program at the agency has approximately 22 full-time equivalent (FTE) staff. So far, the needs versus available resources to implement the program with existing agency staff levels has not been met as evident by the estimated 38 FTE required estimated in the program plan. Therefore, the agency believes a strategy is needed to achieve the goals and that this strategy must accompany the rule process.

As stated above, the proposed rule consists of essentially four parts that deal with the following: registration, technical standards (Standards for Discharge, Design, Construction, Operation and Closure), county feedlot programs, and permitting in general. These parts are the overall foundation of the strategy to achieve the stated goals.

Also as stated above, the proposed rules are intended to increase the field presence of the agency and delegated counties staff. To improve the effectiveness of the field presence, the proposed rules require the owner of each animal feedlot, manure storage area, and pasture to register each of these facilities with the agency. The purpose of this registration is to gather enough information to allow the agency and delegated counties to identify each facility and to prioritize the site visits. Site visits would be prioritized based on the highest potential to impact water quality will be visited first. The agency believes that the information collected in the Level 2 inventories compiled by some counties will provide sufficient information to facilitate this prioritization. This means that those facilities that are closest to water bodies may be a higher priority than those that are great distances from water. Those that are located in areas susceptible to sinkhole development may be a higher priority than those that are not. The program plan includes some of the criteria upon which an inspection list may be prioritized. Exhibit I-4. See the Statement of Reasonableness for part 7020.0400 for more discussion of the need for and reasonableness of the proposed registration requirements.

Among the options available to the agency for regulating animal feedlots, manure storage areas, and pastures, in the past, the agency elected to use permits. Permits were required when construction was proposed at an animal feedlot or manure storage area. In addition to the permit, the facility that applied for the permit might be inspected at some point before, during, or after the construction was completed. Inspections and outreach have not been a significant part of the strategy for regulating animal feedlots, manure storage areas, and pastures.

The permitting requirements of the proposed rules are smaller in scope than previous rules, but they form a very significant shift in the strategy for regulating animal feedlots, manure storage areas, and pastures. In addition to the proposed rule revisions, the agency has undertaken the task of redesigning the feedlot program at the agency in an attempt to optimize (from an environmental outcome standpoint) the use of staff resources. The general direction of the redesign has been to emphasis work to be done in the field and to de-emphasize paper reviews to determine if an environmental goal will be achieved. The lack of a significant field presence is one of the areas in which the agency and the feedlot program were criticized in the Legislative Auditor’s report. See Exhibit G-1. The program redesign, which is a work in progress, has been documented in the form of a program plan for all agency activities related to animal feedlots and manure storage areas. See Exhibit I-4, Program Plan. The program plan is intended to guide the implementation of the proposed rules and addresses the following activities:

- NPDES permitting;
- Non-NPDES permitting;
- Animal feedlot and manure storage area inspection plans and priorities;
- Education and outreach;
- County feedlot program oversight;

- Manure management plan review;
- Construction plan review; and
- Measurement of affect of the proposed rules on the environment (i.e., is the environment improved as a result of the rule and program plan).

As stated above, the impetus for the preparation of this plan was to make the best use of the agency and delegated staff to achieve the best possible environmental outcome. The agency believes that the best environmental outcome will be achieved through an increased field presence. The program plan reflects the emphasis on field presence and the de-emphasis on paper review that can often be the central point of a regulatory system based on issuing permits. Field presence means that staff spends a significant amount of their time in the field instead of behind a desk. This notion, that field presence will be effective, is based on the agency's belief that most facility owners will make every attempt to comply with rules and laws if they are aware of the rule or law and; and if they believe that the rule or law is based on sound reasoning. The proposed rules, as a whole, are intended to allow the agency and delegated counties to shift staff resources from doing paper reviews to doing inspections, education and outreach activities. The proposed rule is intended to allow and encourage the agency and delegated to shift their strategies for regulating animal feedlots and manure storage areas from one of reviewing paper work to one of actually looking at and addressing the issues at the animal feedlots and manure storage areas.

The four main portions of the proposed rule: registration, permitting, county feedlot programs and technical standards are all intended and designed to work together to achieve the best possible environmental outcome. The proposed technical standards, parts 7020.2000 to 7020.2225, establish the minimum location, construction, and operational requirements needed to minimize the environmental impact of these operations. One of the reasons for including the technical standards in the proposed rule is to reduce or eliminate the need to use permitting as the regulatory tool for a large number of animal feedlots and manure storage areas. The proposed rules include clearly stated technical standards that are broadly applicable. By including clear technical standards and making them broadly applicable, individual permits are not needed to impose legally enforceable location, construction, and operating conditions on any facility. These technical standards also reduce the amount of time needed to draft and issue permits for those facilities that still need one.

The proposed rules emphasize the important role that delegated counties play in the regulation of animal feedlots and manure storage areas. The well-run county feedlot programs are part of the model used to develop the program plan and the proposed rules. In these counties, the county feedlot pollution control officer spends a large portion of his/her time at an animal feedlot or manure storage area talking with the owner and affecting the environmental performance of that facility through education. For this reason, it is reasonable and wise to build on the county program that is already in place. The proposed rules are intended to do that and address the deficiencies identified in the Legislative auditor's report. Emulating the well-run county programs will place more agency staff in the field and will result in measurable environmental improvement.

The proposed permitting system is also intended address confusion that exists relative to in the federal NPDES permitting requirements. As discussed in further detail under the Statement of Reasonableness for part 7020.0405, subp. 1, item B, subitem 1, there is some confusion about the applicability of the NPDES permitting requirement for facilities that do not discharge but may have the potential to discharge. The confusion seems to be about the use of the term "potential." Does the fact that manure is present and open to precipitation mean that the facility has the potential to discharge? The proposed rules are intended to address this confusion by requiring the owners of those facilities with more than 999 animal units that can demonstrate that the facility does not meet the definition of CAFO to apply for a SDS permit. It is the intent of the agency to issue a permit that contains the same requirements as would be required in a NPDES permit. This is consistent with Minn. Stat. § 116.07, subd. 7c, that requires the agency to issue NPDES permits to owners of those animal feedlots with 1,000 or more animal units.

Consistent with the current rules, the agency will issue one permit that addresses NPDES and SDS permittees. Thus, facilities issued an NPDES permit will be covered under the same permit as an SDS facility. The National Pollutant Discharge Elimination System permits are intended to address and only have the authority to address discharges to surface water. As stated in Section II of this Statement of Need and Reasonableness, Minnesota statutes provide the agency with the authority to adopt rules and issue permits to for the purpose of preventing pollution of waters of the state of which ground water is a part. The State Disposal System permit addresses potential discharges to ground water, while the NPDES permit would only address surface water discharges. Since discharges from animal feedlots, manure storage areas, and poorly operated pastures have in the past and have the potential to discharged in the future to surface water and ground water, it is reasonable to require owners that are subject to the requirement to obtain a NPDES permit and an SDS permit. Combining these permits into a single permit is allowed under Minn. R. pt. 7001.1010. In order to minimize the administrative burden of apply for and obtaining a permit, it is reasonable to combine the NPDES and SDS permits into a single permit.

Finally, the proposed permitting system takes advantage of the technical standards by reducing the number of permits. Individual permits will be issued where there is a tangible benefit for issuance of the permit, and, where the agency has an obligation to issue such an NPDES permit.

The proposed rules will allow small animal feedlots, manure storage areas (fewer than 300 animal units), and pastures to construct and operate within the constraints of the technical standards without applying for a permit from the agency or the delegated county. Animal feedlots, manure storage areas, and pasture with more than 300 animal units that propose to locate, construct, and operate in accordance with the proposed technical standards will be able to do so under a streamlined permitting system called construction short-form permits. Animal feedlots, manure storage areas, and pastures with fewer than 1,000 animal units will not be required to apply for an operating permit if the facility is constructed and operated in accordance with the proposed technical standards. The agency believes this is reasonable because the standards that would be drafted into individual permits will now be codified in rule. The administrative burden to review for anything other than construction is not warranted and not obtainable with current agency staffing levels.

One of the greatest threats to Minnesota's waters is runoff from open lots at small animal feedlots. See the Statement of Need for further discussion of runoff from open lots. The current rules require that all animal feedlots and manure storage areas comply with the standards of Minn. R. pt. 7050.0215. Attaining this standard is out-of-reach for many of these facilities due to the cost to comply with the standard and the short period of time allowed, under the current Interim permit, to correct the runoff problem. For this reason, owners of these facilities have chosen to do whatever is necessary to avoid contact with the agency to avoid be forced to decide whether to quit operation or fix the problem at a cost that may yet force them out of operation. For this same reason, the agency and delegated counties have not made great efforts to locate these facilities and force that decision. The proposed rules will allow owners of these small animal feedlots (fewer than 300 animal units) until October 1, 2009, to come into compliance with Minn. R. pt. 7050.0215. However, these facilities will also have to commit to and install and operate a system of clean water diversions (diversion to keep uncontaminated runoff from running across an open lot and becoming contaminated prior to entering waters of the state) prior to October 1, 2003. The intent of requiring owners to install the diversions is to achieve a reduction in the quantity of pollutants entering waters of the state by at least 50 percent by October 1, 2003. This in-and-of-itself will have a measurable impact on the water quality of Minnesota.

The proposed rules will then allow the owners time to arrange financing, and potentially a subsidy, for the installation of the manure storage area and/or runoff filtering area needed to comply with Minn. R. pt. 7050.0215. As an alternative to completely fixing the runoff problem, some owners may then decide to cease operating. For further discussion of the cost to install and operate these diversion systems, manure storage areas, and filtering areas, see Section V, of this Statement of Need and Reasonableness, Consideration of Economic Factors. The proposed rules for this group of owners will only be effective if the owners know, and understand what is needed and why it is needed and if there is a credible threat that those who choose to take advantage of the deferred enforcement of the standards of 7050.0215 and do not take the appropriate actions to come into compliance with the standards will be caught and punished. The credible threat can only be demonstrated through a strong "field presence" by the agency and delegated counties.

The proposed system reduces or foregoes completely much of the review that has taken place prior to construction at an animal feedlot or manure storage area. The proposed system allows the agency to dedicate many more staff to being in the field. If owners discover that the proposed rules require less initial oversight and less oversight after a project is complete, the proposed regulatory system will fail. The environmental performance of animal feedlots and manure storage areas will only improve if the agency and delegated counties make a credible effort to place staff in the field to oversee these facilities and ensure that the facilities are located constructed and operated in accordance with the proposed rules. The potential environmental gains that proposed system would allow will not be realized without a strong "field presence."

Under the proposed system, the agency will do less up front review of plans and specs and will do more inspections of construction sites. The agency will issue fewer construction permits and do more education and outreach through personal visits to more animal feedlots and manure storage areas. Under the proposed rules, owners will be required to apply for a permit less frequently but will be more responsible for locating, constructing and operating in accordance with the proposed rules.

As stated in Section IV, item A, subitems 3 and 4, Reasonableness of the Rules, Reasonableness as a Whole, the proposed rules establish an new permitting system for animal feedlots and manure storage areas. Parts 7020.0350 to 7020.1600 establish the proposed registration and permitting system and county feedlot program requirements. The intent of the proposed system is to allow the agency and delegated counties to refocus staff time on issues that will result in the greatest environmental gains. Parts 7020.0400 to 7020.0535 establish the proposed permitting system; a permitting system that places more emphasis on an owner's ability to comply with technical requirements and less emphasis on agency staff issuing permits unless there is a tangible gain to be had by going through the permitting process and issuing that permit. The proposed system is a new way for the agency to regulate these facilities. In many ways, the proposed system is about owners accepting responsibility for the environmental performance of their facility and the agency accepting that these owners will do what is needed if they know and understand what is needed and why it is needed.

C. Reasonableness of the Specific Proposed Rule Parts

This section addresses the reasonableness of specific parts of the proposed rules.

Chapter 7001 Agency Permit Procedures

7001.0020 Scope

This part of the existing Minn. R. ch. 7001 sets forth the requirements applicable to permits and certifications issued by the agency. The existing rule requires permits and certifications to comply with parts 7001.0010 to 7001.0210, except as otherwise specifically provided. The proposed modification to item F of this part is needed to address permitting related modifications to the agency's rules governing animal feedlots, manure storage areas and pastures under Minn. R. ch. 7020.

Item F. The proposed revisions to item F are intended to clarify which parts of Minn. R. ch. 7001 apply to permits issued to animal feedlots, manure storage areas and pastures, and which do not. The current rule states that parts 7001.0040 to 7001.0070 do not apply to an agency permit required for the construction and operation of a feedlot; and part 7001.0100, subparts 4 and 5, and part 7001.0110 do not apply to interim permits. Minn. R. pt. 7001.0020, item F, establishes permit related requirements as summarized in Table 4.

Table 4. Summary of Permit Requirements in Referenced in Part 7001.0020, Item F.

Part No.	Part Heading	Summary of Requirements
7001.0040	Application deadlines	This part establishes the deadline requirements for submitting applications for permits, permit modifications, and permit reissuance.
7001.0050	Written application	This part establishes the requirements for permit application content.
7001.0060	Signatures	This part establishes the requirements for which persons must sign a permit application
7001.0070	Certifications	This part establishes the certification requirements for permit applications with regard to completeness and truthfulness of the information submitted in the application.

The proposed rules state that Minn. R. part 7001.0020, item F, applies to construction short-form permits as well as interim permits as stated in the current rule and described above. As discussed in more detail in the Statement of Reasonableness for part 7020.0405, the proposed construction short-form permit is quite similar to the interim A permits that are issued under the current Minn. R. ch. 7020, in that they allow construction at animal feedlots and manure storage areas. For this reason, it is reasonable to exclude construction short-form permits from part 7001.0100, subparts 4 and 5, and part 7001.0110, as interim permits currently are.

The proposed rules delete the exemption to parts 7001.0060 and 7001.0070 for permits for animal feedlots and manure storage areas. Therefore, under the proposed rules, owners are required to comply with the same signature and certification requirements as all other permits issued under Minn. R. ch. 7001. The signature requirements identify the person that must sign a permit application. The trend in the industry in the recent past has been toward larger animal feedlots with ownership agreements resembling large corporations more than the stereotypical family farm. Since the owner is ultimately responsible for the facility's compliance with all requirements and the ownership structures are as complex as that of large corporations, it is reasonable for the proposed rules to have the same signature requirements as other facilities permitted under Minn. R. ch. 7001. For these same reasons, it is reasonable to require the same certifications as other facilities permitted under Minn. R. ch. 7001.

The current rule states that the requirements under Minn. R. pt. 7001.0020, item F, only apply to animal feedlots. The proposed rules state that these requirements also apply to manure storage areas and pastures that are subject to the permitting requirements. Since manure storage areas and poorly operated pastures potentially have the same pollution problems as animal feedlots (runoff and ground water contamination) and the proposed rule intends to permit manure storage areas where no livestock exist and all problem sites, it is reasonable to establish the same requirements for these operations as animal feedlots.

The proposed amendments to this provision states that part 7001.0050, part 7001.0100, subparts 4 and 5, and part 7001.0110 does not apply to construction short-form permits issued under the proposed revisions to Minn. R. ch. 7020. The permit application content provision (part 7001.0050) is added to the exempted parts of Minn. R. ch. 7001, applicable to construction short form and interim permits because these requirements are incorporated into part 7020.0505 of the proposed rule. This proposed amendment also exempts construction short-form permits from the public notice and public comment provisions. Interim permits are already exempt form these provisions. Construction short-form permits are intended for new or expanding facilities and to replace Interim-A permits and certificates of compliance, which are exempt from these provisions. Interim-A and Interim-B permits and certificates of compliance currently issued by the agency or delegated county for under 1000 animal unit facilities including new construction and expansion projects, or for pollution hazards, do not include requirements for public notice and comment. All applicable requirements of a construction short-form permit are included in the proposed rule. Therefore, all interested parties will have this opportunity for input under this rule making activity and permit requirements are available for review. The agency holds the right to revoke a construction short-form permit. Therefore, if an interested party feels that the s construction short-form permit does not adequately regulate any feedlot with this type of permit, the agency can then take the appropriate actions to address these concerns including requiring the feedlot owner to obtain a different permit. For these reasons, the proposed amendments are reasonable.

The proposed amendments to Minn. R. pt. 7001.0020, item F, are needed to provide consistency between the permitting provisions of this part and the proposed revisions to Minn. R. ch. 7020. The SONAR for part 7020.0405 describes the need and reasonableness of providing appropriate incentives for feedlot owners to apply for a construction short-form permit, one of which is a streamlined permitting process. By exempting these parts from the construction short-form permitting process the streamlined nature of the permit is preserved. Conversely, state disposal system (SDS) permits will be required to meet the requirements of these parts because SDS permits will be issued to feedlots that are not eligible for a construction short-form permits. This is reasonable because these feedlots will be doing something different than the proposed technical standards allow and/or will be large feedlots and manure storage areas (non-CAFOs with 1,000 or more animal units). These types of feedlot specific factors require feedlot specific compliance requirements and schedules to be incorporated into the SDS permit. This provision is reasonable because it provides interested parties the opportunity to review and comment on SDS permits for these different cases.

Chapter 7002 Permit Fees

The agency proposes changes to the water quality fees rules, Minnesota Rules parts 7002.0210 to 7002.0310. The changes are being proposed to: 1) reflect agency organizational changes; 2) clarify the existing requirement that National Pollutant Discharge Elimination System (NPDES) permits that regulate animal feedlots, manure storage areas or pastures will be charged the fees already established under Minn. R. ch. 7002; 3) add the requirement that State Disposal System (SDS) permits that regulate animal feedlots, manure storage areas or pastures with a capacity of 1,000 or more animal units will be charged the fees already established under Minn.

R. ch. 7002; and 4) clarify that no fees will be assessed for construction short form permits and interim permits.

The proposed changes do not change the fee amounts that are already established under Minn. R. ch. 7002. The MPCA is currently charging fees for NPDES permits that regulate animal feedlots, manure storage areas or pastures. However, Minn. R. ch. 7002 uses a broad fee category called "Non-municipal permits, other non-municipal (any flow)" and the agency is proposing language that will clarify that NPDES permits that regulate animal feedlots, manure storage areas or pastures are included within this broad category. This is the fee category currently being used to determine fees for these permits. This rule change is reasonable because it more clearly states the fee requirements for NPDES permits; it clarifies current fee requirements and does not impose an increase in the fee amounts.

The MPCA also proposes to charge the fees under the "Non-municipal permits, other non-municipal (any flow)" category to State Disposal System (SDS) permits that regulate animal feedlots, manure storage areas or pastures with a capacity of 1,000 or more animal units. The MPCA currently does not charge fees for SDS permits that regulate livestock or manure storage facilities. However, the MPCA also seldom issues an SDS permit for one of these facilities. Currently under Minn. R. ch. 7020, "SDS permit" is not listed as a permit tool, but the SDS permit tool does currently exist under Minn. R. ch. 7001. In the agency's proposed permit system, some facilities are required to have an SDS permit. See part 7020.0405.

One of the underlying foundation policies for the proposed permit system is that animal facilities with 1,000 or more animal units pose a significant potential environmental concerns because of the very large amounts of manure and/or process generated wastes that are produced or managed at these facilities. The MPCA is proposing to require an operating permit (a permit that is required for the life of the facility and addresses management and operational issues) for these facilities to address the significant potential environmental concerns.

Under the current MPCA animal feedlot regulatory program, NPDES permits are the only type of operating permits issued and fees are charged for these permits. Under the proposed rules, the MPCA may also issue an SDS operating permit. Since both the NPDES and SDS permits will be operating permits it is reasonable to charge the fees that are currently being charged for NPDES operating permits also for the SDS operating permits. Both the SDS and NPDES permits require the same amount of staff time and resources to process a permit application, develop permit requirements, and conduct inspections, technical assistance and enforcement actions needed to ensure compliance. An operating permit requires more resources than permits that just regulate a construction project because the permit must remain current with the facility. Staff must review and modify the permits whenever there is a significant change in operation, a pollution concern arises, a change in ownership occurs, or for renewal.

The MPCA is proposing to limit charging permit fees for SDS permits to the permits that regulate animal facilities with a capacity of 1,000 or more animal units. The agency has chosen this group of permittees for two reasons: 1) this category of facilities is proposed to be required to have operating permits, and 2) to prevent creating a financial incentive that will cause facility owners to seek the SDS permit rather than the NPDES permit proposed to be required.

As discussed earlier in this section, facilities with a 1,000 or more animal unit capacity are proposed to be required to have an operating permit. Most facilities with less than 1,000 animal units are only required to have permits for the duration of a construction project or pollution hazard correction project, usually no more than 24 months. The MPCA has introduced the SDS permit as an option to the NPDES operating permit currently issued. It is reasonable to require the fee that is currently required for NPDES permits to also be charged for the SDS permit that regulate facilities with 1,000 or more animal units because both the NPDES and SDS permit being issued for the 1,000 or more animal unit category will be operating permits that regulate facilities with similar site conditions and environmental impact issues.

In the proposed rules, the MPCA uses the definition of CAFO as it is stated in the federal regulations. See part 7020.0300, subp. 5a, for a discussion of the reasonableness of this definition. CAFOs are regulated by the federal requirements and must have a NPDES permit. Based on federal CAFO guidance documents, MPCA staff concluded that the 1,000 or more animal unit facilities are included in the CAFO definition. See Exhibit P-2 . Further support for proposing that facilities with 1,000 or more animal units are CAFOs comes from Minn. Stat. § 116.07, subd. 7c, which requires that all facilities in this animal unit category must have an NPDES permit. Staff concludes from this statute that the Legislature has clearly stated that facilities with 1,000 or more animal units are CAFOs.

Since facilities with 1,000 or more animal units are CAFOs under the proposed rules, they are required to have NPDES permits. However, the MPCA has received letters that challenge staff's interpretation of the CAFO definition. See Exhibit P-4. The foundational concern of the agency under the proposed rules is that these large facilities be required to have an operating permit. When the MPCA issues an NPDES permit, it issues a combined NPDES and SDS (NPDES/SDS) permit, which ensures that the permit meets both federal and state requirements. This practice is based in part on MPCA's position that even if the federal Clean Water Act NPDES program did not exist, a person would at least have to get the MPCA SDS permit to construct, operate and use the disposal system that has the potential to discharge to waters of the state. In response to the uncertainty of how the challenge to the CAFO definition will be resolved, the agency has included in the proposed rule under part 7020.0405, subp. 1, item B, subitem (1), that if a facility with 1,000 or more animal units is determined not to meet the CAFO definition then the facility is required to have an SDS operating permit.

Since the MPCA plans to issue NPDES permits to most facilities with 1,000 or more animal units, it is anticipated that issuing an SDS permit for a facility with 1,000 or more animal units will be rare. However, the agency staff is concerned that an administrative problem will result if a fee is charged for an NPDES permit and not charged for an SDS permit. If a fee is not charged for the SDS version of the operating permit for facilities with 1,000 animal units or more than the MPCA staff are concerned that the rules will have established a financial incentive for owners to pursue an SDS permit by challenging the NPDES permit requirement. A demonstration is a written notice from the director of the Environmental Protection Agency stating that the facility is not a CAFO or a finding from a legal proceeding. It is not the intent of MPCA staff to limit facility owner's ability to request a CAFO determination. However, staff wants to limit such requests to facilities that by characteristic of design, operation and management truly are in question of meeting the CAFO definition rather than establishing a method for avoiding fees. Having no fee for the SDS permit would result in a significant amount of MPCA staff resources being spent on non-CAFO determination requests (which may occur in lengthy court proceedings) and will take the staff away from their duties, such as permit issuance and derail the MPCA program procedures. Since having the same fees for both NPDES and SDS operating permits for this animal unit category is reasonable for the reasons stated in the paragraphs above, it is also reasonable to use the permit fees already established under Minn. R. ch. 7002 to prevent creating a financial incentive for challenging the rule definition and to prevent the resulting MPCA program inefficiencies.

The agency is also proposing to charge no fees for interim permits and construction short form permits. No fees are currently charged for interim permits. The construction short form permit is similar in design and is issued to the 300 to 999 animal unit facility category like the interim permit. It is reasonable to propose language that states there is no fees for the interim permit because the language does not change, but clarifies the current fee policy for this permit. It is reasonable to charge no fees for the construction short form permit because this permit is similar to the interim permit and the proposed rules will make the fees the same for these two permits.

<u>Permit Fees Background</u>

The MPCA charges application fees, annual fees and permit modification fees that are used to help defray the costs of developing and issuing permits, conducting inspections to evaluate compliance with permits and regulations, training and outreach programs to educate regulated parties and pursuing enforcement actions. The schedule of fees charged for permits regulating water quality concerns is established under parts 7002.0210 to 7002.0310. For animal feedlots, manure storage areas, and pastures, the agency currently charges permit fees for NPDES permits. These permits are categorized under the "Non-municipal permits. Other non-municipal (any flow)" category under part 7002.0310, subp. 2, item B, and are charged: an $85 application fee, and a $1,230 annual fee for an individual permit or a $260 annual fee for a general permit. If a permit must be modified before the expiration date, a modification fee that is 50 percent of the annual fee is charged as stated under part 7002.0270, item B. No permit fees are currently charged for SW-A permits, interim permits, or five-year permits.

Initially, the agency planned to change the fee structure for permits that regulate animal feedlots, manure storage areas, and pastures. The change in fee structure would permit the agency to increase the number of staff in district and subdistrict offices. The increased staff would permit the agency to increase inspections and field work, better coordinate with local government on feedlot issues, and to process the large number of NPDES permits as required under Minn. Stat. § 116.07, subd. 7c, in a timely manner. See Exhibit F-2, FY99 Legislative Budget Initiative--Animal Feedlot Fees, for a more complete discussion of the MPCA fee initiative. In response to the MPCA's efforts to increase the fees, the legislature passed 1999

Minnesota Session Law, chapter 231, section 2, subdivision 2, was passed and states that the agency shall not approve additional fees on animal feedlot operations until July 1, 2001.

Four laws are important to the proposed fee discussion:

- Minn. Stat. § 116.07, subd. 4d;
- 1999 Minnesota Session Laws chapter 231, section 2, subdivision 2;
- 1999 Minnesota Session Laws chapter 250, article I, section 49; and
- Minn. Stat. § 14.18, subd. 2. See Exhibit F-3.

Minn. Stat. § 166.07, subd. 4d, gives the MPCA the authority to adopt permit fee rules. However, this authority was clouded with the passing of 1999 Minnesota Session Laws chapters 231 and 250. These Laws are discussed further under annual fees, part 7002.0270 of this SONAR.

7002.0210 Scope

Subpart 1. The agency proposes to add part 7001.0020, item F, to the scope of the water quality permit fee rules, parts 7002.0210 to 7002.0310. This is needed to clarify that animal facility permits are included under these rules. The agency is currently charging fees under these parts to owners that are issued NPDES permits that regulate animal feedlots, manure storage areas or pastures. It is reasonable to make this change in scope to clarify that animal facility permits are addressed under these parts. Clearly stating how animal facility permits fit into the water quality permit fee rule parts will make it easier for agency staff to explain fee requirements and for permit holders to understand when they are required to pay fees.

7002.0240 Payment of Fees

The agency is proposing to revise this part by changing “the director of the Water Quality Division” to “MPCA Fiscal Services.” This is needed to reflect a change in the agency’s organization. In 1998, the MPCA underwent an agency-wide restructuring. This effort changed the agency from a pollution-media structure (air quality, water quality, hazardous waste and solid waste/ground water) to the current geographic structure, which is focused on state districts. As a result, the Water Quality Division no longer exists. The agency is proposing that the fee payments are made to the agency’s fiscal services office. This is reasonable because the fiscal services office is responsible for collecting and processing revenues and expenses.

7002.0250 Application Fee

The agency is proposing language under part 7002.0250 to excluding interim and construction short form permits issued under Minn. R. ch. 7020 from the application fees. This proposed language is part of the agency’s efforts to clarify when fees are to be charged for permits that regulate animal feedlots, manure storage areas, and pastures. The agency currently does not charge application, annual or modification fees for interim permits. The agency is not proposing to change this practice. Construction short form permits do not currently exist under Minn. R.

ch. 7020. The agency is proposing to add this permit tool and proposes to treat this new permit like the interim permit and not charge permit fees. Since the agency does not intend to charge fees for the construction short form permit, it is reasonable to state this under part 7002.0250 to clarify that no application fees will be charged. In addition, the MPCA needs to clarify that application fees for SDS permits that regulate facilities with 1,000 or more animal units will not be charged application fees until July 1, 2001. This is the same delay proposed for annual fees under part 7002.0270, item F. See that part for a further discussion on the reasonableness of this delay in charging fees.

7002.0270 Annual Fee

Item F. The agency is proposing to add item F to this subpart to identify when annual fees will be charged for permits that regulate animal feedlots, manure storage areas or pastures. A separate item is needed to address permits issued under Minn. R. ch. 7020 because some of the permits (interim and construction short form permits) are unique to the animal facility regulatory program and not used in other water quality programs and not addressed under the fee parts. The existing fee parts that address fees for water quality permits include fees for NPDES and SDS permits. The agency is proposing to charge fees to only a portion of the NPDES and SDS permits unlike other water quality programs, which assess fees to all permits issued in these categories. Therefore, the agency is proposing language that clearly identifies which permits will be assessed the fees and which permits will be exempt.

The agency is proposing the phrase, “a permittee or applicant for permits issued under Minn. R. ch. 7020 must pay fees as follows:” This language mirrors existing language under item E regarding fees for individual storm water permits. Part 7002.0270 states that “all persons required to obtain a permit . . . shall pay an annual fee for processing of the permit and enforcement . . .” The agency interprets the words “obtain a permit” to mean the submittal of a permit application. Therefore, the agency charges annual permit fees once a complete permit application has been submitted, which begins the sequence of staff work of application review and permit development that leads to permit issuance. The agency proposes to use the word “applicant” here to clarify that annual fees must be paid once a complete application has been submitted to the agency. It is reasonable to clearly describe the agency’s procedures so that agency staff implement the rules consistently and persons submitting a permit application clearly understand that they will be required to pay annual fees before the permit is issued.

Subitem 1. The agency proposes to charge fees for NPDES permits that regulate animal feedlots, manure storage areas or pastures. This language states the agency’s current practice. The agency currently includes these permits under the “Non-municipal permits, other Non-municipal (any flow)” in part 7002.0310, subp. 2, item B. These annual fees are $1,230 annual fee for an individual permit or a $260 annual fee for a general permit. This item is reasonable because it clarifies existing practice.

An excerpt from the 1999 Minnesota Session Laws chapter 231, section 2, subdivision 2, reads: “Until July 1, 2001, the agency shall not approve additional fees on animal feedlot operations.” The NPDES fees discussed in this subitem are not new fees because the fee amounts already exist under part 7002.0310, the agency is charging these fees to these permits under the existing rules, and no fee increases are proposed.

Subitem 2. The agency proposes to charge fees for SDS permits that regulate animal feedlots, manure storage areas or pastures with 1,000 or more animal units. The agency does not currently routinely issue SDS permits to regulate animal feedlots, manure storage areas or pastures. The agency is proposing to change Minn. R. ch. 7020 to require SDS permits for many facilities. See part 7020.0405. The agency is proposing to charge fees only for SDS permits that regulate animal facilities with 1,000 or more animal units because these permits will be operating permits and have nearly the same requirements as the NPDES permits for facilities in this animal unit category. Most other facilities will be required to have permits for construction that adds animal units and to solve a pollution hazard under permits with a 24-month term instead of being required to have on-going operating permits.

The proposed fees for SDS permits are needed to treat all facilities in the 1,000 and more animal units category consistently by charging them all annual fees; and to eliminate any potential financial incentive for facility owners to seek an SDS instead of an NPDES permit. Federal regulations require concentrated animal feeding operation (CAFO) to have an NPDES permit. The definition for CAFO as proposed under part 7020.0300, subp. 5a, incorporates the federal definition, which the MPCA interprets to include facilities with 1,000 or more animal units. However, if a facility in this category is determined through a legal proceeding or any other future process established by the federal government to demonstrate that is does not meet the definition of CAFO, the facility would be issued an SDS operating permit. If no annual fees are charged for the SDS permits in the 1,000 or more animal unit category, the discrepancy in fees would create an incentive for owners to pursue SDS permits instead of NPDES permits. This would create an inefficient component in the permitting system that could bog down the permit issuance process with time spent on requests for determinations and exclusion from the NPDES permit requirement. It is reasonable to charge permits that regulate facilities with similar pollution potential concerns and that are required to have operating permits the same amount of permit fees. This issue is also discussed under the *Reasonableness as a Whole* section.

The 1999 Minnesota Session Laws chapter 231, section 2, subdivision 2, reads: "Until July 2, 2001, the agency shall not approve additional fees on animal feedlot operations." The fees proposed under subitem (2) indicate that for the SDS permits regulating facilities with 1,000 or more animal units could be viewed as new fees. Therefore, the agency requested the Commissioner of Finance's review as required under Minn. Stat. § 16A.1285. See Exhibit F-3. The agency is not proposing a new fee amount, but proposes to apply the fees to a new group of permits. The fee amounts for SDS permits already exist under part 7002.0310. The MPCA has not routinely been issuing SDS permits for the regulation of animal feedlots, manure storage areas or pastures. The SDS permit will be used differently under the proposed rules causing facility owners not required to have an SDS permit under the current rules to be required to have an SDS permit as a result of the rule changes. See part 7020.0405 for a proposed list of facility owners required to have an SDS permit. The agency proposes to extend the fees to SDS permits that regulate facilities with 1,000 or more animal units. Since the MPCA is prevented by this law to impose any additional fees on animal feedlot operations until July 2, 2001, the agency is proposing to begin charging the fees for SDS permits that regulate feedlots with 1,000 or more animal units after July 2, 2001.

The MPCA proposes to require animal feedlots, manure storage areas and pastures with 1,000 or more animal units to have an SDS operating permit if the facility is determined not to be a CAFO. However, the MPCA does not anticipate issuing many of these permits and therefore anticipates to collect very few annual fees from SDS operating permits. Based on federal guidance documents and staff conversations with U.S. EPA representatives, finding an animal feedlot, manure storage area or pasture with 1,000 or more animal units not to be a CAFO will be the rare exception. All other facilities in this category will regulated by an NPDES operating permit with the fees under subitem 1.

The 1999 Minnesota Session Laws chapter 250, Article I, section 49, reads:
“(a) notwithstanding any law to the contrary, an executive branch state agency may not impose a new fee or increase an existing fee unless the new fee or increase is approved by law.”
Section 116(d) establishes the effective date for this requirement to be July 2, 2001. Minn. Stat. § 14.18, subd. 2, already requires new fees or fee increases to be approved by the Legislature. The statutes read:

> “A new fee or fee increase adopted by the MPCA is subject to legislative approval during the next biennial budge session following adoption. The commissioner must submit a report of fee adjustments to the legislature as a supplement to the biennial budget. Any new fee or fee increase remains in effect unless the legislature passes a bill disapproving the new fee or fee increase. A fee or fee increase disapproved by the legislature becomes null and void on July 1 following adjournment.”

The MPCA plans to use the Legislative approval process required under Minn. stat. § 14.18, subd. 2, to fulfill the requirements under Minnesota Session Laws chapter 250. The Minn. stat. § 14.18 process allows the MPCA to adopt the rules before Legislative approve is acquired. Therefore, the agency is proposing the fee rules before seeking Legislative approval. Since the 2000 Legislative Session is not a budget session, the MPCA will present the fees proposed under this subitem to the required Legislative committees during the 2001 session for review and approval as required under Minn. stat. § 14.18. This review will occur before the effective date for the fees proposed under this subpart. If the Legislature does not approve the proposed fees under the Minn. stat. § 14.18 process, the fees will never be charged. Permit fees are calculated and collected based on the state fiscal year. The state fiscal year begins on July 1 and ends on June 30. For the fees for SDS permits that regulate 1,000 or more animal units, this means that the agency will begin charging application fees ($85 see part 7002.0250) for the SDS permits beginning July 2, 2001. However, the annual fees proposed under this subitem will not be billed until April 2002 and required to be paid by June 30, 2002, the end of the state fiscal year. Since the fee rules will already be adopted, the MPCA will have all the materials to present to the Legislature at the beginning of the session and anticipates that a decision will be made before the April 2002 mailing date for the fee invoices. Since the agency anticipates that few, if any, of these permits will be issued. It is anticipated that at the most, only a few SDS fees will be collected because it is anticipated that most, if not all, owners of facilities in this animal unit category will be required to have an NPDES permit and to pay the NPDES permit fees.

Subitem 3. The agency is proposing to state in this subitem that there are no annual fees for interim permits. This subitem states the agency's current practice. This proposed language is part of the agency's efforts to clarify when fees are to be charged for permits that regulate animal feedlots, manure storage areas, and pastures. The agency currently does not charge annual fees for interim permits. The agency is not proposing to change this practice. It is reasonable to clearly state that no annual fees will be charged for interim permits so that staff administer the fees correctly and permittees and permit applicants have a clear understanding of when fees must be paid.

Subitem 4. The agency is proposing to state in this subitem that there are no annual fees for construction short-form permits. The agency is proposing the construction short-form permit as a new permit tool for regulating animal feedlots, manure storage areas and pastures. Construction short-form permits are not currently issued for any water quality regulatory program and the permit will be unique to Minn. R. ch. 7020. The agency is not proposing to charge annual fees for this permit because the permit is similar in design to the interim permit. Like the interim permit, the construction short-form permit is issued for facilities with less than 1,000 animal units, expires after 24 months and does not address on-going facility operation. Even in the 1999 Legislative budget initiative seeking increased permit fees, the agency did not intend to charge these types of facilities permit fees due to the financial hardships currently being experienced by the industry. Due to the discussions that took place during the 1999 Legislative Session and the on-going situations in the farming community, annual fees are not being proposed to be increased and the agency's historical practice of charging permit fees for only operating permits is being proposed to be continued. Since operating permits are only being required for facilities with 1,000 animal units or more, in general, permit fees will only be charged to very large facilities. It is reasonable not to charge a fee for the construction short-form permit because this new permit is similar in design to the interim permit, it addresses facilities that are smaller than 1,000 animal units and it is not an operating permit. It is reasonable to clearly state that no annual fees will be charged for construction short form permits so that staff administer the fees correctly and permittees have a clear understanding of when fees must be paid.

7002.0280 Notification of Error

The agency is proposing to revise this part by changing "the director of the Water Quality Division" to "Minnesota Pollution Control Agency Fiscal Services." This is needed to reflect a change in the agency's organization. In 1998, the MPCA underwent an agency-wide restructuring. This effort changed the agency from a pollution-media structure (air quality, water quality, hazardous waste and solid waste/ground water) to the current geographic structure, which is focused on state districts. As a result, the Water Quality Division no longer exists. The agency is proposing that the fee payments are made to the agency's fiscal services office. This is reasonable because the fiscal services office is responsible for collecting and processing revenues and expenses.

Chapter 7020 Animal Feedlots, Storage, Transportation and Utilization of Animal Manure

7020.0100 Preamble

The proposed rules delete the preamble statement in the current rules. The current preamble is a statement of the goals of the current feedlot rules and contains no enforceable requirements. While it was standard practice to include a preamble in rules, this is not the current practice. The stated goal of "local units of government to provide adequate land use planning for residential and agricultural areas" in the current is incorporated into the proposed part 7020.0200. Additionally, the proposed part 7020.0505, subp. 4, items C and D, and part 7020.2000, subp., 4 and 5 create an enforceable requirement that an owner notify local residents and local government prior to submitting a permit application or constructing when a permit is not required. It is reasonable to delete this portion of the rule, which contained no enforceable requirements. The reasonableness of each of the proposed part 7020.0505, subp. 4, items C and D, and part 7020.2000, subp. 4 and 5 is discussed later in this Statement of Need and Reasonableness.

7020.0200 Scope

The proposed revisions to this part are intended to clarify the applicability of Minn. R. ch. 7020. Minn. R. ch. 7020 applies to owners of all animal feedlots, manure storage areas, pasture operations and all persons storing, processing, transporting and utilizing manure in Minnesota. This chapter applies broadly, not just to owners that are issued permits from the agency. The current rule excludes the county permitting process from this applicability statement, although the county programs are a critical component of the feedlot regulation in the state. It is reasonable to clarify and state as clearly as possible the broad applicability of this chapter to address pollution hazards and potential hazards related to animal manure.

This part has also been changed slightly from the existing rule that excludes "aquatic species." The proposed language "fish" as an alternative to "aquatic species." This change is reasonable because fish is the intended exclusion to the existing rule and the change provides clarification that species such as ducks (which frequently use water) are not part of the exclusion.

The last sentence of this provision states that this chapter does not preempt local units of government from adopting additional regulations related to manure from feedlots, manure storage areas and pastures. This provision is similar to the language in the existing rule under part 7020.0100 (Preamble) that states "the agency will look to local units of government to provide adequate land use planning for residential and agricultural areas." In proposing to repeal the existing language the agency heard concerns that local units of government may view this as the agency no longer taking the position of local units being responsible for land use issues related to animal feedlots. While this was unlikely, the proposed language is reasonable because it clarifies that this rule does not limit local governments to adopt or enforce additional requirements on animal feedlots.

7020.0205 Incorporation by Reference

This proposed all-new part establishes the incorporation of references used in part 7001.0020 and parts 7020.0200 to 7020.2225. Minn. Stat. § 14.07, subp. 4, requires that references to text publications and documents be incorporated into a rule, and the availability of the text identified for the reader. This part thus identifies for the reader that certain documents are used within the above-stated parts and where these documents are available. The need and reasonableness of individual items incorporated by reference is discussed in this SONAR under the specific rule part where it is used. Table 5 summarizes the rule parts where the documents that are incorporated by reference are used in the proposed rule or discussed in this section of this SONAR.

Table 5. Rule Parts Where Incorporated Documents are Used and/or Discussed.

Item Number and Title of Document	Rule Parts Where Document is Used and/or Discussed
Item A. ASTM D 1557, Test Methods for Moisture-Density Relations of Soils, 10 lb. Rammer.	Part 7020.2100, subp. 4, items G and K.
Item B. ASTM D 4318, Test Method for Liquid Limit and Plasticity Index of Soils	Part 7020.2100, subp. 4, items G and K; and part 7020.2120, subp. 3, item B(2).
Item C. ASTM D 422, Method for Particle Size Analysis of Soils	Part 7020.2100, subp. 4, items G and K; and part 7020.2120, subp. 3, item A(2)(a).
Item D. ASTM D 698, Test Methods for Moisture-Density Relations of Soils, 5.5 lb. Rammer.	Part 7020.2100, subp. 4, items G and K; and part 7020.2120, subp. 4, item B(4).
Item E. 40 CFR 412, Feedlot Point Source Category	Part 7020.0300, subp. 19b and 19c; and part 7020.2125, subp. 1, item A. Exhibit A-13
Item F. 40 CFR 122.23, Concentrated Animal Feeding Operations	Part 7020.0300, subp 5a; and part 7020.0405, subp 1, item A. Exhibit A-14
Item G. Minnesota DNR, Protected Waters and Wetland Maps	Part 7020.0300, subp 23; and through special protection area definition in part 7020.2015, subp. 3; and part 7020.2225. Exhibit P-8

Item Number and Title of Document	Rule Parts Where Document is Used and/or Discussed
Item H. USGS Quadrangle Maps	Part 7020.0300, subp 13a and subp. 23; and through special protection area definition in part 7020.2015, subp. 3; and part 7020.2225. Exhibit P-6
Item I. Minnesota NRCS, Waste Storage Pond-Code 425 or Waste Storage Facility-Code 313	Part 7020.2100; and part 7020.2110, subp. 2, item B. Exhibits M-9 and M-15
Item J. Feedlot Inventory Guidebook	Part 7020.0350. Exhibit I-1
Item K. USDA NRCS, Natural Range and Pasture Handbook, Chapter 5, Part 2(i)	Part 7020.2015, subp. 3. Exhibit T-3
Item L. USDA ARS, An Evaluation System to Rate Feedlot Pollution Potential	Part 7020.2003, subp. 4 to 6. Exhibit M-34
Item M. Minnesota NRCS, Prescribed Grazing-Code 528A	Part 7020.2015, subp. 3. Exhibit T-2
Item N. Minnesota NRCS, Heavy Use Area Protection-Code 561	Part 7020.2015, subp. 3. Exhibit T-1

7020.0250 Submittals and Records

Subpart 1, Accuracy of submittals. This proposed all-new part sets forth requirements for submittals and records that apply to persons that are subject to the requirements of chapter 7020. The proposed requirements of this part require any information submitted to the commissioner or the county feedlot pollution control officer to be accurate; if the information is inaccurate, corrected information must be submitted. Since the decisions made by the commissioner or county feedlot pollution control officer can have a significant environmental impact, it is reasonable to require that the information upon which that decision is base to be as accurate as possible.

Subpart 2. Record retention, access to records, and inspections. This subpart requires persons subject to the requirements of this rule to keep the required records for at least three years. Since the records that are required are an integral part of being able to determine if a person subject to these rules has complied with the rules, it is reasonable to require all records to be kept for some period of time.

Some pieces of information are critical and must be kept for longer than the three years required under this part. The proposed rule require a person to keep a record for at least six years for manure applied in special protection areas (part 7020.2225, subp. 5). Owners proposing construction projects such as liquid manure storage areas, would be required to submit the plans and specifications to the commissioner or county feedlot pollution control officer where they will be held for the life of the structure. Three years is a reasonable length of time to keep records for all but the most critical pieces of information.

The proposed requirements also require any person that is subject to the requirements of this chapter to allow the commissioner, county feedlot pollution control officer, or a designated representative to inspect any facility or records pertaining to the requirements of this chapter. As stated above, the decisions that are made by the commissioner or county feedlot pollution control officer need to be based on the most accurate information available. One important information gathering method is through facility and record inspection. For this reason, it is reasonable to require persons subject to the requirements of this chapter to grant access to facilities and records to the commissioner or county feedlot pollution control officer of authorized representative.

These provisions are also a restatement of the provisions of Minn. Stat. § 115.04.

7020.0300 Definitions

Subpart 1. Scope. This subpart establishes the meaning for terms ascribed in Minn. Stat. §§ 115.01 and 116.06, and Minn. R. pt. 7020.0300 when used in this chapter. When a term is defined in both statute and in this chapter, the definition given in statute is the authoritative meaning for the purposes of these parts. The proposed amendments modify this scope to reflect this approach and to correct the reference to the definitions section from Minn. Stat. § 115.07 to the correct reference Minn. Stat. § 115.01.

Subpart 1a. Above ground manure storage area. "Above ground manure storage area" is a term used in several locations in part 7020.2100 for describing a type of liquid manure storage area. Defining this term is needed to establish that the important factor with these manure storage areas is that the liner is above natural ground level. This definition is reasonable as it allows part 7020.2100 to simply state the storage type, much like the term "composite liner" is used.

Subpart 4. Animal Manure. "Animal manure" and "manure" are terms that apply not only to animal excreta, but also to any excreta that is combined with other substances at a feedlot site such as straw, sawdust, other forms of bedding, soil, and/or water. The definition of "animal manure" now includes the term "manure" as having the same meaning for the purposes of these parts. This addition allows use of the more commonly used term "manure" in the livestock industry compared to the more formal term "animal manure." The definition includes milkhouse wastes and other waste waters at an animal feedlot, manure storage area or pasture that contains any manure. Milkhouse wastes and other process generated waste waters are typically produced from cleaning and/or flushing procedures at livestock operations which mix with animal excreta and therefore present the same pollution threat as manure itself. Precipitation, including rainfall and snowmelt, has also been added to the definition to clarify that when mixed with excreta the precipitation and resulting runoff may contain substantial manure pollutants and create a significant environmental hazard. Therefore, it is reasonable to identify these liquids as animal manure and, for clarity, to include them as part of the definition of animal manure.

Subpart 5. Animal Unit. For purposes of administering applicable state and federal regulations related to animal feedlots, manure storage areas and pastures, the most common species of livestock are assigned an animal unit value which is based, in part, on the amount of manure each produces. The language and specific animal unit values proposed in this definition meet the requirements of animal unit values assigned in federal regulations under 40 CFR 122.23, appendix B. However, several additional animal unit values are listed to provided clarity and are needed to fill gaps in the federal animal unit criteria. These additions are reasonable, as states have the authority to have regulations which are more stringent than the federal regulations which are intended to address only the largest facilities and others having the most significant pollution problems. As discussed in this SONAR in the Reasonableness as a Whole and under part 7020.0405, the state of Minnesota has significant surface and ground water and soils resources which justify regulation of facilities not covered by the federal regulations which regulate only surface waters. Since the EPA is in the very early stages of seeking comments to redefine these values, aligning the animal unit values with federal regulations also provides the agency with better justification to change these values if and when the federal regulations change.

A common misconception regarding these animal unit values is that they are used to establish requirements for manure storage capacity and land application acres. While there are rules of thumb for storage capacity and acres needed for land application, the specific requirements vary greatly and are based on a range of site-specific features and management practices. This should not be confused with the requirements of item J of this subpart, that assigns an animal unit value to a facility that stores more manure than is produced at the facility. For determining manure storage capacity, for example, the agency uses manure and wastewater production data published in Midwest Planning Services, MWPS-18 to estimate the required storage capacity. See Exhibit F-1. The Natural Resources Conservation Services also has specific design standards for designing manure storage capacity that do not use animal unit data. Changes in livestock feeds, manure storage, handling and land application methods and the variability of manure nutrient content, eliminates the appropriateness of animal units as single criteria to use when determining requirements for storage and land application.

Animal unit values are important consideration for livestock producers because they may impact the cost of regulation. Certain animal unit thresholds impact the type of permit an owner is required to apply for and obtain and, therefore, may affect the fees or permit processing procedures to which the owner will be subject. For example, owners with 1,000 animal units or more, or is issued an NPDES or SDS permit will pay fees, while an owner with fewer than 1,000 animal units that is in compliance with the rules would not have to pay fees. Because of the regulatory and economic implications, it would be irresponsible to ignore these factors during the rule-making process and therefore, the proposed amendments establish new animal unit values to provide a consistent framework for the various animal species, one which can be used for both state and federal permitting requirements. In evaluating the existing animal unit framework the agency considered the adequacy of the existing definition for regulatory fairness, consistency with EPA criteria, and where available consistency with current industry data regarding animal weights and manure production characteristics. The following additions and changes are proposed based on that evaluation:

Item A. The dairy cattle animal unit language has been modified to read identical to the federal regulations. This change is reasonable because it does not change the meaning or outcome of animal unit assignments for this species. This change simply provides clarity. The second change to this item relates to the establishment of a new animal unit value of 1.0 for mature dairy cows under 1000 pounds, while maintaining that dairy cows over 1000 pounds are assigned a value of 1.4 each. The agency considered adding a specific value for jersey cows, but selected a weight-based criterion instead, because the weight-based criterion provides consistency with other parts of this definition of animal unit. This change is reasonable because it does not overburden dairy breeds such as jersey cows that have a mature weight of about 900 pounds and have been demonstrated to produce a significantly lower volume of manure than a 1400 pound dairy cow breed. Since it is the pollutants in the manure for which these rules are intended to regulated, it is reasonable to base an animal unit value on a demonstrated difference in manure volume. The selected value of 1.0 more accurately represents the per-animal manure and wastewater production rates of a jersey cow as compared to other species of mature dairy cow. Data to support this change was provided to the agency by the Minnesota Department of Agriculture, Dairy Development Specialists. See Exhibit P-5. This proposed change could be viewed as providing a less restrictive regulatory structure for jersey cows (and any other dairy cow breed weighting less than 1000 pounds at maturity) than EPA currently requires. The agency acknowledges that a difference exists, although, the agency believes that the intent of the EPA regulations is to establish thresholds based on the potential pollution hazard at a given facility. As described above, jersey cows have been demonstrated to produce a significantly lower volume of manure that other dairy breeds, therefore the agency believes this change is consistent with the intent of the federal regulations.

Item B. The addition of the term “feeder cattle” to this item is needed to create consistency with EPA values. It is reasonable because it allows the agency and delegated counties to administer a program, which does not conflict with federal requirements. This is also reasonable for owners of facilities who may otherwise not have been aware that they are listed in federal regulations. For example: an owner having feeder cattle weighing about 800 pounds could interpret the existing rule under (the same as item I in the proposed rule) as assigning a value of 0.8 animal unit per cattle, whereas federal regulations would assign these animals a value of 1.0. If not clarified, this could be problematic for owners having facilities at or near the 300 animal unit or 1000 animal unit permitting thresholds in federal regulations.

Item C. The changes to this item have not resulted in a change in animal unit assignments to swine, but the existing rule has simply been combined into one item for swine.

Item D. The animal unit value for horses was changed from 1.0 to 2.0. This is needed and reasonable to provide consistency with federal regulations. Administration of the current rule, which is less restrictive for horses than federal regulations has not caused any permitting related problems to date as only one horse facility in Minnesota is over the 1000 animal unit threshold that requires an NPDES permit. This facility would be over 1000 animal units with the value at 1.0 or 2.0.

Item E. The term “or lamb” was added to the language in this item. This is needed and reasonable to provide consistency with federal regulations.

Item F. Item F lists the assigned animal unit values for chickens. The proposed amendments involve two parts: first to provide consistency with federal regulations and second to fill the gap for chickens, which are not addressed by the federal regulations. Subitem 1 is language directly from the federal regulations. Subitem 2 establishes values for chickens not covered in subitem 2 into chicken over and under three pounds. Adding the 0.033 animal unit value for laying hens or broiler chickens (if the facility has a liquid manure system) is needed to meet the federal regulations. Subitem 2 maintains the value in the current rules of 0.01, but distinguishes this value from chickens weighing less than three pounds. Establishing a value for chickens over and under three pounds, provides a clear and consistent method of distinguishing between chicken pullets and adults and is reasonable because it fills a gap in the federal regulations which do not specifically address non-layer or broiler pullets. At the time of transfer from a brooder barn to a layer or broiler barn, as applicable, a chicken weighs less than three pounds, which is approximately one-half the weight of an adult layer or broiler chicken. Therefore, an animal unit value of 0.003 (or about 30 percent of the animal unit value for adult layer hens or broilers) is reasonable to assign to chickens under three pounds because it is consistent with the value that would be obtained by dividing the three pound maximum weight by 1000 pounds according to the method under item I of this subpart. These changes are needed and reasonable because they establish a consistent approach to federal regulations and the approach currently used for other livestock species within this chapter where a weight range is used to distinguish animal unit values.

Item G. Item G lists the assigned animal unit values for turkeys. The agency proposes to modify the existing language by establishing separate values for turkeys weighing more or less than five pounds. This change is needed and reasonable because, similar to the changes to the dairy cow unit values, brooder turkeys under about five pounds, produce less manure than the adult turkeys. This change is reasonable because it provides a clear and consistent method of distinguishing between turkey poults and adults, similar to other livestock species within this chapter where a weight range is used to distinguish animal unit values. The term turkey poults commonly applies to young turkeys that are less than four to six weeks in age, however, for the purposes of these parts, a poult turkey is one weighing less than five pounds. At the time of transfer of a poult from a brooder barn to a grower/finisher barn, a turkey poult weighs less than five pounds. Poults at this stage weigh approximately 12.5 to 25 percent of the weight of turkeys that are ready for market (light hens weigh approximately 18 pounds; heavy toms weigh approximately 40 pounds). Therefore, the assigned animal unit value of 0.005 (30 percent of the animal unit value for adult turkeys) is conservative and a reasonable value to assign to this category.

Item H. There has been no change to the animal unit value to ducks, which was previously listed as item E.

Item I. There has been no change to this provision, which was listed at the end of the animal units values in the current rule. The agency considered several additional animal unit values, which were not specifically included in the proposed rules because they could be determined though this provision which divides the average weight of the animal by 1000 pounds. Several examples (for the animal types the agency considered incorporating into the rule) of how this provision would be used by are provided below.

> Example 1: One calf equates to 0.2 animal unit. An industry trend is for livestock producers to concentrate on one stage of the livestock maturity cycle. The 0.2 animal unit value is reasonable because it appropriately falls within the range of weight assigned to this animal type from 0 to 500 pounds. The 0.2 is lower than the midpoint of this range (0.0 to 0.7 animal units) because the calves typically spend a higher percentage of time below the midpoint weight than above, thus the assigned value represents an approximate weighted average.
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> Example 2: One beef cow with calf equates to 1.2 animal unit. The reasoning for this value is to more accurately assess the number of animal units at cow/calf operations. Cow/calf operations, also know as beef-grazing, or range operations, are operations where new-born calves are kept with the mother cows for several months until they are weaned and moved to a separate location. These types of operations are common in the pasture-grazing areas of northern Minnesota. The animal unit value 1.2 was obtained by adding the animal unit value of a slaughter steer of heifer (1.0 in item B) to the value assigned to a calf equal to 0.2.
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> Example 3: Dairy young stock equals 0.7 animal unit. Various regulatory levels (state, county and township) use values ranging from 0.5 to 1.0 animal units for young stock. The animal unit value of 0.7 animal unit represents the size (and therefore the manure production rate) of a dairy young stock animal as approximately one-half that of a mature dairy cow animal. The animal unit value of a mature dairy cow is 1.4, therefore, the animal unit value of a diary young stock is half of that value, or 0.7.
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> Example 4. One sow with litter less than 18 days old equals 0.4 animal unit. This is the same animal unit value assigned in the existing rule to any swine greater than 55 pounds, including any sow. The manure production rate of a sow and with piglets less than 18 days old is approximately the same as the sow prior to the delivery of the litter. The alternative to the proposed value is to assign each piglet an animal unit value of 0.05. Based on the manure production rate, the primary factor in assigning an animal unit value, an animal unit value of 0.05 for each piglet under 55 pounds would significantly over state the number of animal units. For these reasons, it is reasonable to assign a sow and litter less than 18 days old the same animal unit value as a mature sow with no litter. Since the piglets are moved to a separate facility at about 14 days of age; the 18 day criterion provides a reasonable margin of error to accommodate this practice. After the 18 day period or before 18 days if they are no longer with the sow, the piglets are assigned the value of 0.05 animal units per animal which is applicable to all swine under

55 pounds. Stating this a different way, the piglets must be both with the sow and be under 18 days of age, or they are assigned a value of 0.05 animal units.

Item J. Item J is needed to establish a method for assigning animal unit values to manure storage areas that store or process more manure than is produced at the animal feedlot. This provision is also needed for calculating comparable animal unit values for manure storage areas or manure processing facilities where livestock are not present. This addition is needed and reasonable because the animal unit values listed in items A to I apply only to the number of animals present and may not account for the entire volume of manure present at a feedlot or manure storage area. Since manure is the primary source of pollutants associated with livestock production, it is reasonable to establish a method for assigning animal unit numbers at facilities which only store or process manure and at facilities which store or process more manure than they generate.

Item J sets forth two options for determining the animal units assigned to the types of facilities described above. Subitem 1 applies when the type of livestock that produced the manure, and amount of manure present is known for all sources of the manure stored or processed at the facility. Under these circumstances, the animal units are calculated for a facility is equal to the number of animal units that produced the manure. For example, a manure storage area where no livestock are present and which receives 50 percent of the manure at a 1000 animal unit swine operation and 25 percent of the manure produced at a 1000 animal unit dairy facility, will be assigned 750 animal units. Subitem 2 applies when the type of livestock or amount of manure from each type of livestock is not know for all manure sources. This provision provides a clear and consistent method for assigning animal units at all facilities storing or processing manure that are not covered under subitem 1. The assigned value is based on the quantity of manure handled annually in pounds, divided by 4,000. This method is based on the most conservative estimate of animal units per pound of manure produced for all of the species discussed in items A to H. Annual manure production values are based on estimates in MWPS-18. See Exhibit F-1. The agency recognizes that this method may seldom be used, however, the proposed method is needed for those few owners without sufficient information to determine an animal unit number under subitem 1. The proposed method is a conservative method of estimating the number of animal unit, which produced a quantity of manure. It is reasonable to establish a conservative method to provide an incentive for owners to know the type of manure they are handling, thus providing the basis for better and more consistent manure land application practices and nutrient utilization.

Subpart. 5a. Concentrated animal feeding operation or CAFO. Certain types of feedlots and manure storage areas are regulated by EPA under 40 CFR 122.23. See Exhibit A-14. These feedlots and manure storage areas are defined by criteria set forth in 40 CFR 122.23 and are referred to by EPA as CAFOs. Minnesota has approximately 800 known feedlots that may be classified as CAFOs and, therefore, that are subject to EPA regulations. The MPCA administers EPA’s animal feedlot program and issues National Pollutant Discharge Elimination System permits to CAFOs as part of the state animal feedlot regulatory program. The proposed rules establish permit type eligibility limitations and permit requirements based on the facility being classified as a CAFO or not (part 7020.0405). The agency has included the term “manure storage area" in the definition of CAFO to clarify that manure storage areas which store 1000 animal unit or more of manure are also CAFOs. This is supported by EPA in section 2.1 of their draft "Guidance Manual and Example Permit For CAFOs" document dated August 6, 1999. This document states that "EPA defines the animal feeding operation (AFO) to include the confinement area and the storage and handling areas necessary to support the operation (e.g., waste storage areas)." Therefore, the definition and meaning of CAFO in these rules is needed and reasonable to establish a distinction between CAFOs and non-CAFOs and to cite the EPA regulation that establishes the criteria for determining which facilities are CAFOs.

Subpart 6. Certificate of Compliance. The agency has added the term "manure storage area" to this definition. This was needed to clarify that manure storage areas located where no animal feedlot existed were issued certificates of compliance under the existing rules. This is a reasonable addition because, as discussed in other parts of this SONAR, the presence of and potential pollution from the manure is the most important factor considered by this program in the regulation of livestock operations.

Subpart 6a. Commencement of Construction. The agency proposes to include this definition in the revised rules because feedlot and manure storage area construction related to animal unit expansions and/or construction on a manure storage area cannot begin until a permit has been obtained and/or the applicable notification requirements have been met. This definition is needed to clearly identify for the owner, delegated counties and the agency precisely when construction begins and when construction beyond a point is prohibited without a permit or submittal of a notification. Providing a definition for commencement of construction clarifies and fulfills this need. This definition is based on part 7001.1020, subp. 8, item A, and has been modified to apply specifically to animal feedlots and manure storage areas. This definition does not in any way limit pre-construction investigation work needed to gather site-specific information for site planning and design. The proposed rules are intended to limit activities that the owner can do prior to permitting or construction activities. The activities are limited to those that after which the cost to stop construction is not so high that it is difficult or impossible to stop. For example, the proposed rule would not allow the installation of perimeter drain tile systems prior to permit issuance. The cost of these systems may be significant enough that stopping a project after this point would be a significant loss to the owner. One intent of the proposed rule is to limit the amount of money an owner would lose due to constructing a facility that cannot be issued a permit due to things such as facility design or location. Another intent of the proposed rule is minimize the number of contentious disagreements between the MPCA and facility owners as a result of the owner proceeding beyond the point at which the cost to make changes becomes significant. In cases where the owner has a significant investment in a site or facility, the incentive for the owner to continue the project is great. These contentious disagreements result in delays and increased costs for both the owner and the MPCA. It is reasonable to define as clearly as possible the point at which construction commences to avoid these unnecessary costs and delays.

Subpart 7. Change in Operation. The agency proposes to repeal this definition from the rules. This term is no longer used, therefore, it is reasonable to repeal this definition.

Subpart 7b. Composite liner. This definition sets forth the meaning for a manure storage area liner system that achieves theoretical seepage rate of 1/560 inch of depth per day or less. There are several typical liner systems which can currently be designed and installed to achieve the seepage rate standard. See Exhibit M-20. Typical liner materials used include at least a double liner consisting of a geomembrane (flexible membrane) liners such as polyvinyl chloride and high density polyethylene or geosynthetic liners which typically have bentonite-clay materials contained within a synthetic fabric, placed over two or more feet of cohesive soil. The lower seepage rate (compared to the seepage rate requirement of 1/56 inch of head per day or less for other areas) is required for manure storage areas in areas with geological conditions which are susceptible to soil collapse, sinkhole formation or other areas with a high potential for contaminating drinking water supplies. In the karst areas, the lower seepage rate is beneficial to reduce the risk of inducing soil collapse (due to movement of soil under the manure storage area due to seepage through the liner system).

The proposed rules also require two feet of compacted soil under the primary liner material, which provides a secondary barrier to the contents seeping into the ground. The phrase "other comparable liner materials" is needed because the changing nature and availability of these products requires that the rules be flexible enough to accommodate equivalent products that are yet-to-be developed. The proposed definition is reasonable because the seepage rate standard is achievable and is necessary in areas which are susceptible to soil collapse or sinkhole formation. See the Statement of Need and Reasonableness discussion for the proposed part 7020.2100, subp. 3, item B, subitem 3 for more discussion.

Subpart 7c. Compost. The agency proposes to include a definition for compost in the proposed rule because a part 7020.2150, which specifically addresses composting of manure, has also been proposed. Therefore, it is reasonable to include this definition to clarify for readers the agency intent on the type of activities to be managed as compost and not raw manure.

Subpart 8. Corrective or protective measure. The agency has added the term "manure storage area or pasture" to the definition of corrective or protective measure. This was needed to clarify requirements for manure storage areas and pastures, which create or maintain a pollution hazard can be required by the agency or county to install these measures. This is a reasonable addition because, as discussed in other parts of this SONAR, the presence of and potential pollution from the manure (whether at an animal feedlot, manure storage area, or pasture) is the most important factor considered by this program in the regulation of livestock operations.

Subpart 8a. Construction short-form permit. The term "construction short-form permit" is used in the proposed rules to identify a permit issued by the agency or county feedlot pollution control officer to owners of feedlots or manure storage areas with fewer than 1,000 animal units that are proposing to construct or expand. The construction short-form definition is reasonable to include in the rule because it allows the term to be used in the text without repeating the citation and provides a clear distinction from the interim permit. Providing this distinction between interim and construction short form permits is needed because under the existing rule, the agency and delegated counties issue interim (A) and interim (B) permits. The interim (A) permits are primarily for new and expanding construction activities and the interim (B) permits are for addressing pollution problems. The agency intends to clearly distinguish between the two permit types by name the construction permit appropriately and restoring the original intent of the interim permit to be issued for pollution problems.

Subpart 9. County feedlot pollution control officer. The agency proposes several modifications to the definition for county feedlot pollution control officer. First, to relate "county feedlot pollution control officer" to "delegated county" the phrase "a county employee or officer" is proposed to so that the definition reads "an employee or officer of a delegated county." Second, the phrase, "knowledgeable in agriculture" is deleted because the definition and applicable parts of this rule do not provide specific criteria for a qualified candidate. Therefore, "knowledgeable in agriculture" does not contribute to the meaning of the definition and it is reasonable to delete it. And last, the agency proposes to replace the phrase "receive and process animal feedlot permit applications" with "perform the duties under part 7020.1600." The phrase "receive and process animal feedlot permit applications" does not adequately express the range of duties of a county feedlot pollution control as proposed in part 7020.1600. The phrase "perform the duties under part 7020.1600" provides broader scope and resolves this problem and, therefore, it is a needed and reasonable change.

Subpart 9a. Delegated county. State statutes allow a county board to assume responsibility for processing animal feedlot permit applications. This responsibility is authorized by the agency and upon approval by the agency, a county becomes delegated, and subsequently designates a county feedlot pollution control officer. Upon delegation, most of the regulatory work is done at the local level and, in particular, by the designated county feedlot pollution control officer. Providing this definition in the revised rules is needed and reasonable because it clearly distinguishes between a delegated county and a county feedlot pollution control officer. It establishes the fact that delegation means authorization and that the feedlot regulatory work done by a delegated county parallels the feedlot permit processing conducted by the state.

Subpart 9b. Design engineer. The addition of this definition is needed and reasonable because it clarifies the individuals that may prepare designs and reports for manure storage areas as required under this chapter. The definition also eliminates the need to use the phrase "professional engineer, licensed in the state of Minnesota or qualified Natural Resources Conservation Service (NRCS) staff person working under NRCS approval authority" in each of the many uses of the term "design engineer" throughout the manure storage requirements parts of this rule. Engineers not licensed by the state of Minnesota are not considered "design engineers" under these parts unless they are a qualified NRCS staff person as described above. All design plans and specifications, construction reports and other submittals prepared by registered professional engineers and NRCS staff persons must comply with applicable statutes and rules. Designs by NRCS staff persons are also expected to comply with appropriate NRCS practice standards and procedures. For these reasons, it is reasonable to define the term "design engineer" and establish these minimum qualifications.

Subpart 9c. Discharge. Discharge includes animal manure or manure-contaminated runoff from an animal feedlot, manure storage area, land application site or manure transportation or processing equipment, that enters any water of the state in any quantity or concentration by any means. Discharge is a generic word that potentially has a wide array of meanings and without a definition, the meaning may be selectively interpreted or misinterpreted. The proposed definition is intended to be used broadly and to include any discharge of pollutants to waters of the state, intentional or unintentional. Many terms are commonly associated with the discharge of manure such as manure-contaminated runoff, dumping and seeping which are among those included in the definition. These terms are intended to convey the meaning that any release of pollutants to waters of the state from a feedlot, manure storage area or field is a discharge. The proposed definition also includes an exception for seepage within the parameters and under the conditions allowed in this chapter. Specifically, these parameters and conditions are:

- Seepage within the permeability requirements for manure storage areas (1/56, 1/560 of an inch of head per day or 1×10^{-7} cm/sec); and
- Seepage through structures for which the proposed rules contain a construction standard in lieu of a permeability specification that are constructed in compliance with the specifications proposed in these rules.

Subp. 11a. Expansion or expanded. The term, expansion or expanded, is defined for this chapter because they are used often throughout the rule and a clear and consistent meaning is essential. The terms mean any proposed increase in the capacity of an animal feedlot to hold animals over what is authorized or any increase in the storage capacity of a manure storage area. Inherent in this definition is that any new feedlot or manure storage area is, by definition, expanding. The definition is needed to distinguish between an increase in animal units at animal feedlots and manure storage areas (including an increase in manure storage volume at a manure storage area located where no animal feedlot exists) within the quantity authorized. For example, an owner that has a permit authorizing 500 animal units but has only 300 present, is not expanding for the purposes of this definition when increasing the number of animal units to 500. However, the same owner is expanding if there is an increase above 500 animal units, whether or not construction will be needed. In this situation, the owner may simply be extending the area available for livestock by installing more fencing or may be using an open lot, which was not used under the existing permit. Similarly, expanding the storage capacity of a manure storage area with or without an increase in animal numbers is an expansion under this definition. This definition establishes a trigger for permit or notification requirements for the owner when increasing the capacity of a site. Any animal feedlot or manure storage area that is expanding is required to obtain a permit, obtain a permit amendment or submit a notification. The proposed definition is reasonable since expansion of an animal feedlot or manure storage area can result in an increase in the potential for negative environmental impacts from the facility and a clear trigger for regulatory review is needed.

Subpart 12a. Flow distance. Flow distance is a new term that defines a distance measurement, which may be a measurement other than a simple straight-line distance. The definition is needed to establish a difference between a straight horizontal distance and the distance manure-contaminated runoff may travel following preferential flowpaths before reaching waters of the state. It is reasonable to define the term “flow distance” because the intent of the agency is to establish a setback, which relates to a level of runoff treatment or buffering effect. The term “flow distance” allows facilities to take into consideration the mitigating effects of runoff traveling a longer distance than the straight-line distance from the source to waters of the state. Increasing the flow distance decreases the potential for negative environmental impact on waters of the state. The proposed definition is reasonable since it encourages owners to increase the minimum distance that runoff must travel to waters of the state and allows them to do so in an area much smaller than would be necessary with a 300-foot setback requirement.

To protect waters of the state from manure-contaminated runoff, the proposed rule typically restricts manure-handling and application operations in areas adjacent to or near these waters. The established straight-line setback distance for stockpiling is 1,000 feet from lakes and 300 feet from most other surface waters. Under the flow distance concept stockpilers may place sites much closer than 300 feet to a surface water provided a barrier in the form of a berm or natural rise of lands is present to divert runoff such that it travels a minimum of 300 feet before it enters the surface water. This mechanism provides flexibility to stockpilers and to owners of fields containing stockpile sites. It allows stockpiles to be placed closer to access roads and it keeps the stockpiles closer to the perimeter so that field operations are not disrupted. At the same time, the flow distance requirements meets other feedlot setback requirements in the degree of protection provided. Therefore, this provision is both needed and reasonable.

Subpart 13. Interim Permit. This definition has been modified to refer to the more detailed description of the interim permit applicability to owners, issuance and requirements compared to the current definition which simply states that the permit expires within 10 months of issuance. This change is need and reasonable because the applicability and procedures for interim permits have been expanding in the proposed rule (for example, specifically the 10-month period has been changed to 24 months).

Subpart 13a. Intermittent Streams. The addition of intermittent streams to the definitions is needed because it is used in the definition of special protection areas and in the land application requirements. Intermittent streams are used to identify watercourses that, in seasonally wet conditions or during periods of heavy precipitation convey water to ditches, streams and other waters of the state. The agency has designated the United States Geological Survey (USGS) quadrangle maps as the reference for identification of intermittent streams. See Exhibit P-6. The USGS maps were chosen as the reference because these maps identify seasonally wet streams with sufficient detail to allow interested parties to identify them. United States Geological Survey Quadrangle maps are available at local Soil and Water Conservation Service offices, delegated county feedlot offices, and at the Minnesota Department of Natural Resources website (www.dnr.state.mn.us). The proposed definition is reasonable because it provides a readily available and consistent method for identifying these waters.

Subpart 13b. Manure-contaminated runoff. The agency proposes to add this definition to the proposed rule to described liquids that contain or have come in contact with manure that flow from an animal feedlot, a manure storage area or a land application site. The intention of the definition is to make it clear that any liquid that has been in contact with manure is manure-contaminated runoff. The definition will help to prevent misinterpretation, disputes or confusion related to compliance issues associated with runoff from areas containing manure. These matters can arise easily since manure-contaminated liquids can originate from, and may occur in so many forms at, a feedlot site.

Manure or liquid may be generated from the urine of animals, from precipitation which lands on the site, or from external water that enters a feedlot or manure storage area and picks up manure particles. Interested parties must be clear that the origin of the liquid that combines with manure to create manure-contaminated runoff is not relevant; the fact that the liquid has been in contact with manure is relevant. The definition of manure-contaminated runoff is also important in what it does not say. Unlike the term discharge, this definition does not specify or imply a discharge to waters of the state. While manure-contaminated runoff can result in pollution, pollution is not necessarily the outcome of all manure-contaminated runoff. For example, runoff control structures collect manure-contaminated runoff but neither the runoff nor the manure stored in basin is considered to be pollution. This neutral connotation of manure-contaminated runoff is important to distinguish situations where manure-contaminated runoff is present but a discharge to waters of the state has not occurred. This term is also important, for example, when the agency or delegated county identifies a potential problem at a facility where an actual discharge has not been observed, but the presence of manure-contaminated runoff very near waters of the state has been observed. This distinction allows the agency or delegated county to use the definition of pollution hazard under part 7020.0300, subp. 19a, item B, where the term "potential" is used. The agency or county could then issue an interim permit to initiate correction of the potential problems.

Subpart 14. Manure storage area. The term, manure storage area, is used throughout the rule as a term to identify those parts of livestock operations that are used to store animal manure either at, or separate from, an animal feedlot. Modification to this definition is needed to more clearly establish the applicability of these rules to manure storage areas and processing operations (e.g., manure compost sites) and to distinguish manure storage areas from manure accumulations or mounding. As part of this modification, the phrase "associated with an animal feedlot" has been deleted so that manure storage areas constructed independent of the location where the manure was produced are included in the meaning of the term "manure storage area". The phrase "until it can be utilized as domestic fertilizer or removed to a permitted animal manure disposal site" has also been deleted because it does not provide any useful criteria for a manure storage area; there are other uses of animal manure. This deletion does not change the meaning. The term "processed" has been added to the definition to include storage at operations where manure may be treated by methods other than land application such as composting.

For clarity, the agency has added language to specifically identify manure stockpiling sites and manure composting sites as manure storage areas. The term "animal holding" area has been inserted to make it clear that manure pack and mounding applies only for manure packs or mounds that have been created within an animal holding area. The addition of the reference to part 7020.2000, subp. 3, has been added to clarify that while manure packs and mounding are not manure storage areas, they are regulated by the feedlot rules. These are needed and reasonable modifications to this definition because they clarify the agency's intention to regulate manure storage areas, whether at an animal feedlot or at a separate facility.

Subpart 15. New animal feedlot. The term "new animal feedlot" refers to the construction, establishment or operation of an animal feedlot or manure storage area at a location where none existed in the past or to a reactivation of an animal feedlot, at the same location that it had been in operation in the past, which has not been used for at least three years. Under the current rule, an owner may leave the animal feedlot empty for up to five years without having to submit a permit application. The modification from five to three years in this definition is needed to better address the deterioration of animal holding and manure storage areas that occurs when these facilities are not used for extended periods. Some components of a facility deteriorate during periods of disuse, such as below-ground earthen and concrete manure storage structures, which are particularly susceptible to damage when they stand empty for long periods. Each freeze-thaw cycle subjects these structures to stresses which cause fissures, cracks and other structural damage to develop and each season subjects earthen liners to erosion from rainfall and runoff. Significant erosion and freeze-thaw desiccation of an earthen liner can occur in three years or less and is very likely to occur if not maintained for more than about three years. Under these circumstances, the only regulatory option to assure that reactivated facilities are safe to resume operation is to require more frequent review and inspection.

The proposed changes accomplish this goal by requiring the facility to meet new facility standards. The term "abandoned" has created confusion in the past due to the perception that an "abandoned" structure should not or could not be returned to service. The deletion of the expression "has been abandoned" is also reasonable because it eliminates this confusion, and the definition is complete without it. For these reasons, the proposed changes to this definition are reasonable.

Subpart 16. National Pollutant Discharge Elimination System (NPDES) permit. The term NPDES permit means a federal permit that is issued by the agency under authority granted by the United States Environmental Protection Agency. The phrase "point source including" has been deleted since a CAFO, according to Section 502 of the Clean Water Act, is a "point source" and the proposed rule does not address regulatory domains other than animal feedlots, manure storage areas and pastures. The term "concentrated animal feeding operations" has been replaced by its more commonly used acronym "CAFO." The changes to this definition are reasonable because they help clarify the applicability of NPDES permits within this rule.

Subpart 17. Owner. Addition of the phrase "manure storage area or pasture" to the definition of owner is needed to establish consistency in this rule with regards to ownership of animal feedlots, manure storage areas and pastures which are regulated under the rule. In the current rule, it is somewhat unclear if a manure storage area that is not located at an animal feedlot is subject to the permitting requirements of Minn. R. ch. 7020. The proposed rule requires manure storage areas to be treated equal to animal feedlots with respect to permit requirements. Owners of animal feedlots, manure storage areas or pastures are also required to register under the proposed rule and apply for an interim permit if determined to be a pollution hazard. Therefore, the addition of this phrase to the definition of owner is reasonable.

Subpart 18. Pastures. The term "pasture" is used to define a type of livestock operation where the animal's feeding needs are primarily met through grazing perennial grasses and forages. The existing and proposed rules do not consider a pasture to be an animal feedlot which is subject to permitting, provided that temporary supplemental feeding device is located outside of any special protection area and the pasture is not designated a pollution hazard by the commissioner or county feedlot pollution control officer. If the temporary supplemental feeding devices are located in a special protection area, the facility would be considered potential pollution hazard and could be required by the agency or delegated county to relocate the feeding devices and to eliminate any actual or potential pollution hazards created by the feeding devices placement.

The proposed amendments are intended to make the definition of "pastures" more closely match the image of a grass covered area in which animals graze. Experience with the current definition has demonstrated its weaknesses. Some feedlot owners have attempted to use the definition of "pastures" to argue that an animal feedlot in question is a pasture based on the fact that vegetation, no matter how little, grows in some part of the area. The proposed amendments clarify the requirement that a cover of perennial grasses or forages must be maintained. The intent of this again is to make the definition match the image of a grass covered area in which animals graze. Even with this amendment, someone will still try to argue that if a single blade of grass is growing in an area, the area is a pasture and therefore, a permit is not required. The intent is to require a vegetative cover throughout the pasture, such that soil erosion and runoff from the area is not a problem. In an attempt to establish clear guidelines for what constitutes a pasture, the proposed amendments also establish the requirement that supplemental feeding devices must be located outside of special protection areas. The proposed amendments still allow supplemental watering devices to be located within special protection areas. The supplemental feeding devices must be located outside of special protection areas to minimize the impact of the animals congregating around the feeding device. By requiring the feeding device to located outside special protection areas, the animals will spend the majority of the time away from waters of the state and the chance of manure contaminated runoff form entering the waters is significantly reduced. Watering devices are allowed in the area to minimize the cost of pumping the water from the water body to the watering device. These pumps are operated by cattle pushing the pump with their nose and therefore pumping the water uphill or long distances to the watering device could create unnecessary cost to these owners. Since the watering device will be closer to the feeding device, it is reasonable to assume that the animals will prefer to drink from the watering device as from the water body (for pastures for which the proposed rules allow the animals to have direct access to the water body).

Animals at those animal feedlots that meet the definition of CAFO are not allowed direct access to a water body under the proposed rules. For these reasons, it is reasonable to amend the definition of "pastures" to require the vegetative cover to be a perennial grass or forage and to require temporary feeding device to be located outside of special protection areas.

Subpart 18a. Permanent stockpiling site. This definition is needed because the proposed feedlot rules regulate manure stockpiling in two categories; permanent stockpiling sites and short-term stockpiling sites. Both types of stockpiling are manure storage methods that consist of placing relatively dry manure in piles on either natural relatively low permeability soils or on constructed pads having much lower permeability. The distinction between the two types of stockpiling are based on a range of criteria including how long the stockpile is maintained prior to land applying the manure and the volume of manure stored. The definition also states that a permanent stockpile site is a manure storage area. This definition establishes that any stockpile not operated to meet the short-term stockpile requirements is, by definition, a permanent site. This ensures that all stockpiles are regulated.

Subpart 19. Permit. The agency proposed several modifications to the definition of the term "permit". The agency proposes to delete the phrase "at no charge to the applicant." This rule language governs fees for state permits and the agency is proposing to change the permit fee rules to charge fees for SDS permits that regulate feedlots with 1,000 or more animal units. See need and reasonableness discussion under part 7002.0270, item F. The phrase "county feedlot pollution control officer" has been added because County feedlot pollution control officers (CFOs) are authorized to issue permits under this chapter. Adding CFOs to the definition is needed and reasonable revision because provides accuracy to the definition.

The agency has also modified the language to read "which may contain requirements, conditions, and/or schedules for achieving compliance with the discharge standards, management of animal manure, construction, and/or operation of animal holding areas and manure storage areas" to the existing definition is intended to clarify the wide range of compliance requirements place on owners in permits and that must be followed. The term, animal holding areas, is intended to be broad and include, for example, such areas as pastures, livestock sale barns, or transfer stations and fairgrounds. Feedlot permits not only regulate discharges of manure; they regulate operational methods and practices for management of feedlot pollutants. Adding this language completes the meaning of what a permit is. Therefore, this change is reasonable to make to the existing definition.

The proposed definition identifies the types of permits which may be issued by the agency and/or CFO to owners of animal feedlots, manure storage areas and pastures. By doing this the agency is able to use the generic term "permit" whenever permits or permitting related-matters are addressed in the rule. This is a reasonable approach since it allows use of the broad term instead of listing all permit types each time a general reference to any permit is used throughout the rule. In addition, listing the names of the permits issued under this amended rule helps distinguish these permits from the various permits (e.g., SW-A, 5-year and interim) and certificates of compliance that were issued under the current rule. The SW-A permit, the 5-year permit and the certificate of compliance will no longer be issued under the amended rule. However, even if an owner was issued one of these documents previously under the existing rule, there exists the requirement for the owner to apply for a permit under the amended rule pursuant to part 7020.0405, depending on the specific factors present at the facility.

Finally, while not specifically stated in this definition, all owners of CAFOs issued an NPDES permit will be issued a combined NPDES/state disposal system (SDS) permit. Because the federal regulations only address discharges of pollutants to surface waters, the combined NPDES/SDS permit is needed and reasonable to allow the agency to regulate the discharge of pollutants from CAFOs to all waters of the state including groundwaters, and to address air quality and other issues such as those addressed in the permit application section under part 7020.0505, subp. 4, item B. The agency also realizes efficiencies in processing applications and taking permit actions on CAFOs by issuance of a combined NPDES/SDS permit.

Subpart 19a. Pollution hazard. The agency proposes to add the definition of pollution hazard, in exchange for the potential pollution hazard definition deleted (see subpart 20 discussion in this SONAR). This definition is intended to more clearly identify what specific criteria must be met to be a pollution hazard by referring to the criteria incorporated into the proposed rule in parts 7020.2000 to 7020.2225.

Item A of this definition describes two criteria that must be met: (1) that an owner is not complying with the standards in parts 7020.2000 to 7020.2225 and (2) that the owner has not obtained a NPDES or SDS permit. This item is needed because it is integral to the permitting system in parts 7020.0405 to 7020.0535. The application of these permits to owners not meeting the standards is discussed in more detail in this SONAR for part 7020.0405. However, the key issue with respect to this definition is that an owner can clearly interpret what specific factors must be followed so that they are not defined as a pollution hazard. It is important to note here that an owner is not necessarily creating or maintaining an actual pollution hazard to waters if they are a “pollution hazard” under item A. Under this scenario, the owner has not demonstrated to the commissioner through the NPDES or SDS permitting process that their alternative approach (to those in parts 7020.2000 to 7020.2225) will not create or maintain a pollution hazard. This provision is reasonable because, when considered with the permitting structure presented in part 7020.0405, it allows an owner to propose alternative methods by stepping through a more involved permitting process. This is also reasonable for the concerned public and the agency because it allows the commissioner to more closely review design, construction or operation methods which do not fit the standard methods, resulting in greater assurance that facilities will not create or maintain actual pollution hazards.

Item B of this definition is needed to give the commissioner or county feedlot pollution control officer the ability to designate a facility a pollution hazard upon inspection. The main differences between this definition and the old “Potential pollution hazard” definition are that the proposed definition specifically requires an inspection; and the definition specifies factors that must be considered when determining the extend of pollution hazard present at a facility. These criteria are again needed and reasonable because they set boundaries on the discretion of the inspector.

The term “potential” has also been included in item B to allow the commissioner or county feedlot pollution control officer to designate a facility that has a high risk of pollution in the future. Two examples are provided to illustrate the meaning of potential.

> First, a liquid manure storage area under construction which appears to have significant construction defects which must be corrected prior to manure being added to the manure storage area. Under this example, the permitting authority could require the owner to obtain an interim permit to correct a problem, whether the owner was originally issued a construction short-form permit (300-1000 animal units) or no permit (fewer than 300 animal units). This is reasonable, because in reality the owner

would not have complied with building the manure storage area according to the original plans and specifications, which met the standards in part 7020.2100. Therefore, the facility could be considered a pollution hazard under item A, either way the owner is subject to an interim permit to correct the potential or likely problem.

Second, consider the example of an owner that proposes a facility of 299 animal units located just a few feet outside of the shoreland setbacks in part 7020.2005 and is located at the top of a steep ravine leading to the water body. The commissioner or county feedlot pollution control officer could require an interim permit, which could include many of the same conditions in a construction short-form permit to have better oversight of the new or expanding facility. This is reasonable because the proposed facility is just outside two of the permitting thresholds including the 300 animal unit threshold for a construction permit and the location restrictions. In several discussions with county feedlot officers during 1999, many expressed concern that the word "potential" should be removed from the definition. However, the agency proposes to include "potential" because several counties also expressed the desire to have permitting authority for facilities under 300 animal units which have potential pollution problems.

Subpart 19b. Process generated waste waters. The agency proposes to add this definition which is needed to provide consistency with federal regulations (as defined in 40 CFR 412.11 (d), Exhibit A-13). This definition is reasonable because it provides clarity to regulatory agencies and facility owners that more than manure is regulated under the federal feedlot regulations and this rule.

Subpart 19c. Process wastewaters. The agency proposes to add this definition to provide consistency with federal regulations (as defined in 40 CFR 412.11 (c)). This definition is reasonable because it provides clarity to regulatory agencies and facility owners that more than manure is regulated under the federal feedlot regulations and this rule. An example of the wastewater to be addressed under this definition is the runoff of liquid from a silage storage area. This wastewater does not contain manure, but still has pollutants such as high levels of biochemical oxygen demand, which can significantly impact waters of the state and therefore, should not be overlooked.

Subpart 20. Potential pollution hazard. The agency proposes to delete the definition of potential pollution hazard in exchange for the pollution hazard definition in subpart 19a. The definition contained a complex set of general criteria that reference sensitive locations, geological conditions, discharge standards, shoreland, sinkhole, well considerations and water quality standards. These criteria have been incorporated into the proposed rule in parts 7020.2000 to 7020.2225, and the agency found that this grouping of criteria under one concept did not fit well with redesigns made to the permitting system and establishment of the standards in parts 7020.2000 to 7020.2225. The deletion of the term is reasonable because of this redesign of the rule, which no longer uses these terms in the regulatory framework.

Subpart 20a. Separation distance to bedrock. The addition of this definition is needed to provide a clear and consistent meaning of "separation distance to bedrock" when used mainly in the liquid manure storage area, part 7020.2100. This definition is reasonable because it accomplishes this goal by providing a less cumbersome read of the rule parts where it is used. The definition identifies the separation distance as between any stored manure and bedrock, throughout all areas of the liner system.

This definition is also needed to eliminate the past confusion when design engineers or contractors viewed the separation distance requirements to mean either: the distance between the manure and bedrock (as in this definition); or the distance between the bottom of the liner and bedrock. The confusion has not been a critical problem when dealing with concrete liners, since the liner itself is only 4 to 5 inches thick. However, when considering a 4-foot thick earthen/cohesive-soil liner which requires a separation distance of 5 feet, the actual required distance between manure and bedrock could vary from 5 to 9 feet if a clear definition is not established. Under the proposed definition, the separation distance of 5 feet for this example with a liner thickness of 4 feet would result in one foot between the bottom of the liner and bedrock.

Subpart 21. Shoreland. "Shoreland" is a statutory definition cited in the existing rule. The agency proposes to modify the definition by adding a citation to Minn. Stat. § 103F.205, subd 4. The revision will allow the meaning of shoreland to remain consistent with any changes that are made to the statutory citation of shoreland. On the basis that this modification ensures regulatory consistency, this revision is needed and reasonable.

Subpart 21b. Short-term stockpiling site. This definition is needed because the proposed feedlot rules regulate manure stockpiling in two categories; permanent stockpiling sites and short-term stockpiling sites. Both types of stockpiling are manure storage methods that consist of placing relatively dry manure in piles on either natural relatively low permeability soils or on constructed pads having much lower permeability. The distinction between the two types of stockpiling are based on a range of criteria including how long the stockpile is maintained prior to land applying the manure and the volume of manure stored. This definition states that a short-term stockpile site is a manure storage area that complies with part 7020.2125, subp. 1 to 3. This definition is needed and reasonable because it establishes clear criteria by which a stockpile can be identified as either a short-term or permanent stockpile.

Subpart 22. Sinkhole. The sinkhole definition has been modified to align with definitions found in current literature as described in "Sinkholes and Sinkhole Probability" maps published by the Minnesota Geological Survey. See Exhibit M-21. The map describes a sinkhole as: "Sinkholes are closed depressions that form by the solution of underlying soluble bedrock and function as connections between surface and ground waters. Sinkholes are intermediate in size between larger karst features such as blind valleys and smaller karst features such as solution pits." It is needed and reasonable to revise the definition to reflect the most contemporary meaning and understanding of this term.

Subpart 23. Special protection area. The agency proposes to add the term "special protection area" to the definitions to identify land that borders selected waters of the state. The designated areas are lands within 300 feet of Department of Natural Resource protected waters and wetlands and some intermittent streams and identifiable ditches on United States Geological Survey quadrangle maps. The special protection area definition is used in the proposed rule for land application of manure, part 7020.2225. For example, manure applied within special protection areas must meet more rigorous requirements than manure applied outside of the special protection areas.

The primary reason for establishing the special protection area system is potential pollution risk associated with manure and its proximity to waters of the state. Unless protective measures are present, manure that is generated, stored, land applied, or otherwise handled near those waters creates a higher environmental risk than when these activities are conducted a greater distance from these waters. As stated in Basis and Justification for Minnesota Land Application of Manure Guidelines "(t)he 300-foot distance chosen as the special management zone for surface water protection is believed to represent a reasonable distance which provides a reasonable degree of environmental protection base on the literature, yet not be unreasonable to livestock producers." See Exhibit L-2. For this reason, it is reasonable to base the definition of "special protection area" on a setback of 300 feet.

The intent of the defining "special protection areas" is to provide a framework for protecting the most valuable and important waters of the state (as opposed to all waters of the state, which is broader in scope). The proposed definition represents the agency's effort to develop rules that will provide the greatest environmental benefit without resulting in unreasonable restrictions for those being regulated. The agency accomplishes this end by selecting waters that are of highest priority to the public, those identified by the DNR Public Waters classification system which was created by the DNR in accordance with Minn. Stat. § 103G.201 to identify waters bodies of greatest importance. These waters are also identified on DNR Protected Waters and Wetlands maps. See Exhibit P-8.The definition also includes land with 300 feet of intermittent streams and some identified ditches because these water bodies and watercourses ultimately flow to lakes and other public waters. It is, therefore, reasonable that land bordering these water bodies and watercourses are subject to a higher level of protection.

Special protection areas can be clearly and consistently identified on maps which are readily accessible. Protected waters and wetlands are identified on DNR protected waters maps. Intermittent streams and ditches are identified on United States Geological Survey (USGS) 7.5 minute and 15 minute Quadrangle Maps. These maps are available through the Minnesota Department of Natural Resources website (www.dnr.state.mn.us); Minnesota Department of Administration; Minnesota's Bookstore, 117 University Avenue, St. Paul, Minnesota 55155; and Maps Distribution USGS Map Sales, Box 25286 Federal Center, Bldg. 810, Denver, Colorado 80225. These maps are also available at public libraries, local Soil and Waters Conservation District (SWCD) offices, MPCA offices and most delegated county offices. Therefore, the means of identification of special protection areas by owners of animal feedlots and manure storage areas for permit application requirements and manure land application purposes is reasonable.

Subpart 24. State disposal system permit or SDS permit. SDS permits are those permits that are issued under statutory authority in Minn. Stat. ch. 115. The agency also has the authority to issue permits through the federal permitting program known as NPDES permit program. Owners that meet the criteria of a CAFO, will be issued a combination permit that contains the requirements for both NPDES and SDS permits. The intent of the proposed definition is to clearly identify the authority under which state permits for animal feedlots and manure storage areas are issued. SDS permits are issued according to the agency's procedures required in part 7001. Interim permits and construction short form permits are exempt from certain procedural elements required under part 7001.

Subpart 25. Unpermitted/Non-certified Liquid Manure Storage Area. This definition is needed and reasonable to eliminate the need to use the two criteria throughout the applicable requirements in this rule. The two criterion, of which the owner need only meet one, for defining an unpermitted manure storage area include: not having an agency or delegated county permit or certificate of compliance for the manure storage area although the owner was required to apply for and obtain a permit or certificate of compliance prior to the construction and/or operation of the manure storage area; and not complied with the pre-operational requirements of part 7020.2100 and permit requirements. This definition is also reasonable because it provides the owner a clear listing of the criteria without having to refer directly to the section requiring corrective action on an unpermitted manure storage area.

Subpart 26. Waters of the State. The term "waters of the state" describes the bodies of water that are to be protected under the proposed rules. The term is very broad. Those areas designated as special protection areas are areas in which the risk of polluting waters of the state is high either due to the areas proximity to water and the risk of direct runoff to it is high or the presence of a conduit (i.e., ditch, pipe, or intermittent stream) to easily transporting pollutants to waters of the state. The definition included here is identical to the statutory definition established in Minn. Stat. § 115.01, subd. 22. One clarifying note is that the term "irrigation systems" which is included in the definition is not intended to prohibit land application of liquid manure in accordance with part 7020.2225, for example, from a center pivot irrigation system, or traveling gun.

Registration Program

7020.0350 Registration Requirements for Animal Feedlots, Manure Storage Areas and Pastures

The agency is proposing to incorporate a regulatory tool known as registration into the agency's feedlot program. Registration is an administrative approach to regulation that collects fundamental information from all parties subject to a set of regulations and puts it into an organized information and management system. The agency proposes to use registration in the feedlot for the following reasons:

- As a tool to locate livestock and manure storage facility owners and identify high priority environmental problems;

- As a method of conveying regulatory and education information to livestock and manure storage facility owners; and
- As a tool to collect data for the further development and implementation of the feedlot regulatory program.

Livestock and manure storage area facility owners must satisfy the registration requirement in one of three principal ways. First, they may submit a completed registration form to a delegated county feedlot officer or agency. Second, their operation may be identified on a level II inventory that has conducted by the county. Submittal of a completed permit application is a third alternative by which owners may meet registration requirements.

All feedlots must be registered in 2001. Registered owners must update their registration every four years. Registration consists of providing:

- Property identification information;
- Owner information;
- Basic facility operational information; and,
- Location information.

A main feature of the registration program is that the registration requirements have been designed to correspond to the basic facility data collected from level II feedlot inventories. Level II feedlot inventories are inventories that have been conducted by counties according to the Feedlot Inventory Guidebook. See Exhibit I-1. Many counties have completed level II inventories. See Exhibit C-5. Information from these inventories may be used to complete or partially complete the data requirements of the registration program, provided that the inventory data can be supplemented with the required additional information. As a result, in counties where level II inventories have been conducted, much of the work needed to accomplish registration has already be completed. For counties that do not maintain a current level II inventory, registration implementation will typically consist of four steps. Livestock and manure storage facility owners will be identified through the use of existing data such as tax records, existing topographic maps that show feedlot sites, and producer association records. Identified owners will be mailed forms. Completed and returned forms will be processed. Additional follow-up to owners not responding will be achieved by phone calls, drive by sighting, and working through township officials.

The impetus for developing a registration program emerged in April of 1999. The agency's original administrative approach to regulating feedlots was through a comprehensive permitting program. Under that system all feedlots were proposed to be permitted. However, when the plan for permitting everyone was matched with agency resources, it became apparent that staffing levels were not sufficient to conduct a comprehensive permitting program. See letter dated June 4, 1999, in Exhibit I-5. As an alternative the agency proposed a registration system in combination with a limited permitting program. The strategy was to shift the tools used for achieving regulatory compliance from permitting to inspections and from the agency to the county programs. The inspection program would be supported by a high quality database identifying the location of most feedlots in the state. The database would be maintained through the registration program. The registration component was refined in the course of several FMMAC meetings and was, ultimately, supported as a useful tool in regulating livestock and manure storage area facilities.

Subpart 1. Generally, subpart 1 establishes a registration data component to the feedlot program. Subpart 1 contains provisions that are key to shaping the registration program. The provisions contained in subpart 1:

- State that registration applies to not only animal feedlots, but also to pasture operations and manure storage facilities.
- Establish an October 1, 2001 deadline for meeting registration requirements.
- Define the information that is required to be gathered and maintained. The information required must meet the level II inventory information required in the Feedlot Inventory Guidebook and also include minimal supplemental information as described below.

The agency is proposing that the registration requirements apply to pastures. Pastures are livestock operations where the livestock are primarily grown and produced by grazing them on grasslands or other fields with growing plants. Beef-grazing and cow/calf operations are typical examples of pasture operations. In many of the northern counties of the state, this is the most common type of livestock agriculture.

One of the needs to require registration of pasture operations relates to the goal of regulation. The registration program is intended to keep the agency informed on the general status of livestock operations in the state. This includes information on such areas as animal numbers and density. For this information to be accurate it is necessary that the agency has data on pasture operations. It should be noted that information will only be required from pasture operations with 50 or more animal units unless the pasture is in shoreland. It should also be noted that grazing operations that do not meet the definition of pastures as described in 7020.0300, subpart 18, will be subject to registration under the classification of a feedlot. Finally, the registration requirement should not be interpreted to mean that the level of regulation will increase for this category of feedlots.

Another reason why the agency proposes to require pasture operations to be registered is that it's not always easy to distinguish a pasture operation from other types of livestock operations. Some livestock operations are a combination of pasture and feedlot operations. For example, at some livestock operations livestock are pastured during the growing season and, then, confined to open lots and buildings during the winter months. Owners of these operations may be unclear as to whether or not they are required to register. For the above reasons including the need for accuracy of information, planning regulatory strategy, and avoiding creating a confusing regulatory picture for livestock owners, it is needed and reasonable that registration covers all significant livestock operation including pasture operations.

The agency is proposing that registration includes a deadline by which livestock and manure storage area facility owners must be registered. The reason is that, for the information to be useful, it must be current. This is true whether the information is being used to prioritize and direct inspections, to serve as a mailing database, or to use for analysis in doing program development. The deadlines established by the agency for registration are intended to keep the information current to within four years. The agency believes that this span of time strikes a balance between having a database that contains information reasonably representative of the livestock and manure storage area facilities in Minnesota and a regulatory requirement that is not overly burdensome to those who are subject to it.

The agency is establishing deadlines in two phases. There is the initial phase under which registration is required by October 1, 2001. There is the on-going phase, which is set up on a repeating basis of four-year cycles. The rationale for setting October 1, 2001, as the initial registration deadline is based on a sequence of events that begins with the adoption of the proposed rule. As of November 1999 the agency is estimating that adoption of the rule will occur sometime in August of 2000. At or about the time of adoption, the agency will initiate an outreach and information program to educate affected parties on the contents of the revised rule. This rather intense educational phase should last between six months and one year and be completed by the summer of 2001. The agency's strategy is that the registration deadline should occur near the end of the educational phase. The reason is that livestock and manure storage area facility owners should be at a peak in their understanding of the proposed rules and its obligations. At this time they will be most aware of their registration obligations and will be most likely to comply with them. It is reasonable for the agency to establish procedural requirements that are designed to accommodate practical considerations. The need and reasonableness for registration deadlines established after October 1, 2001 is addressed in this SONAR for subpart 4, item B.).

Subpart 1, items A to K is a list of information requirements that must be met in order for registration to be complete. The agency proposes to establish the information requirements in items A to K for the following reasons:

- The requirements provide owner and property identification needed for the purpose of inspections and to provide data for agency planning and analysis purposes.
- The requirements provide adequate information for the agency to reasonably assess the pollution-risk factor of a facility.
- The requirements allow information from level II or level III inventories to be used along with minimal supplemental information, to meet information requirements for registration.

This set of information requirements developed from discussions with FMMAC at meetings on June 14, 1999, and on August 11, 1999. At these meetings many viewpoints regarding the goals of registration and the information needed from owners to meet those goals were shared. Exhibit I-2. Emphasized and agreed upon in these discussions were the general guidelines that the registration form should:

- Yield information needed to identify feedlot location and prioritize problem feedlots;
- Provide assurances that registration would not result in punitive enforcement actions;
- Be reasonably short and easy to use; and

- Not be intrusive.

One aspect of the discussion on registration did not get fully resolved. This controversy centered on the amount of compliance information that an owner should be required to disclose on the registration form. For example, one of the proposed information requirements required owners to disclose whether or not their manure pit had ever overflowed. Some thought that it would be counterproductive to require feedlot owners to submit this information. They thought that owners would be reluctant to provide information that would indicate non-compliance and, therefore, make registering these owners more difficult. Others thought that putting compliance evaluations on the registration form simply fulfilled an agency regulatory philosophy of making owners more responsible for evaluating the compliance status of the operation and design of their facility.

The agency created two prototype registration forms to clarify issues related to the type of information needed to be obtained from registration. See Exhibit I-3. One form was designed after the level II inventory described in the Feedlot Inventory guidebook. The level II inventory requirements require livestock operation owners to disclose feedlot size, animal type, type of manure storage and distance to surface water. The other form was designed to provide a more comprehensive assessment of potential pollution problems. It required livestock and manure storage area facility owners to disclose the occurrences of non-compliance at the facility such as a manure storage basin overflow or the over application of manure to land. This was presented to FMMAC prior to the October 11, 1999 meeting but a decision on the matter of registration content was not finalized.

The agency is proposing to use the information requirements according to A to K because it satisfies two important considerations related to the registration program. One is that it provides adequate information for the agency to reasonably assess the pollution-risk factor of a facility and to generate a comprehensive database on livestock operation location. Second, the information requirements contained in A – K should be available from many of the level II inventories that have already been conducted by the counties. This linkage between the two systems (level II inventories and registration) allows existing information from level II inventories supplemented with readily available additional information to be used to meet registration requirements.

The Feedlot Inventory Guidebook is an inventory guide that was put together by several state agencies in 1991. See Feedlot Inventory Guidebook Exhibit I-1. It has become established as an authoritative and useful regulatory guide for conducting animal feedlot inventories in Minnesota. It is the reference guide used by counties to conduct feedlot inventories. Legislative appropriation funds for the feedlot grant program are based on level II and level III feedlot inventories as described in the Feedlot Inventory Guidebook. The agency is proposing that the Feedlot Inventory Guidebook and the corresponding level II inventory be made an integral part of the registration program. While the value of using information from Feedlot Inventory Guidebook inventories for registration has been discussed, it is important for clarity to discuss how the Feedlot Inventory Guidebook affects the terms and conditions of the registration program.

The registration information requirements contained in subpart 1 are defined by the Feedlot Inventory Guidebook and by items A to K. It may seem confusing that both of these methods are used to define and identify registration requirements. The reason for this is that while the agency wants to continue to use the Level II inventory of the Feedlot Inventory Guidebook as the definitive guide for establishing registration information requirements, the agency, also, wants to make sure that registration provides the four basic categories of feedlot information – owner, property, operations and pollution-risk.

Often, the information contained on a level II feedlot inventory conducted by a county will meet all information requirements listed in A to J of subpart 1. However, agency experience is that most counties use a code on their inventory spreadsheets for identifying facility owner name, address and location. This code may be in the form of a property identification number, a watershed designation, a fire number or a key to geo-locational computer software such as Arcview. As a result the submitted inventories do not directly identify the owner and property information as required by subpart 1, items B to D. The agency needs easily accessible owner, address and property information to achieve the goals of registration. Therefore, the agency proposes to itemize the information requirements A to J as a way to avoid receiving level II inventories that do not fully comply with registration requirements. Itemizing the information requirements also removes any ambiguity between the agency and the county as to what a level II inventory as described by the Feedlot Inventory Guidebook means.

Item A requires that a completed registration form be dated. The feedlot registration program has time-related parameters and, therefore, a provision is needed to establish the date when the registration information was completed.

Item B is information that is required to identify the names and addresses of the owners. This information is needed for the agency to provide information and to otherwise correspond with the owners of animal feedlots, manure storage areas, and pastures.

Item C is information that is required to identify the location of an animal feedlot, pasture or manure storage area. Location information must be provided in the standard format of county, township, section, and quarter section. Facility location is information needed to support the conducting of inspections and to aid in feedlot program planning and analysis.

Item D. According to item D, owners of animal feedlots, pasture or manure storage areas that have been permitted or received a certificate of compliance must record the permit/certificate of compliance on the registration form. The significance of a certificate or a permit number is that it indicates that a facility has been reviewed for compliance by either the agency or county staff. As a result, a permitted facility or a facility with a certificate is likely to have a lower potential to pollute than a facility that has not been permitted or does not have a certificate of compliance. This information is useful for regulatory strategies that rely on evaluating pollution-risk. Certificates and permit numbers are also useful for retrieving information on databases and for accessing records.

Item E requires that registration data be obtained on the method of livestock confinement used by owners of animal feedlots. The type of holding areas used to confine livestock correlates to the level of pollution risk at a facility. For example the opportunity for runoff is much greater from a livestock operation with open lots than one where animals are maintained under a roof at all times. This is useful information for the agency to have when prioritizing feedlots for such purposes as conducting inspections.

Item F requires that registration data be maintained on the number and type of livestock confined at livestock operations. The amount of waste generated at a livestock operation is in direct proportion to number of animals located at the site. Also, manure characteristics differ among animal types. Therefore, this is important information for the agency to have available to assess an operation's potential to pollute. This information is also fundamental for conducting feedlot program planning and analysis.

Item G contains registration requirements related to the distance of manure production/storage to surface waters. One of the prime indicators for evaluating the level of pollution risk at a site where manure is produced and/or stored is the distance from these sites to surface waters. The setback requirements from surface waters for siting new feedlots, manure stockpiling, and the land application of manure documents is evidence of this fact. This is essential information for the agency to have when prioritizing feedlots for such purposes as conducting inspections.

Item H addresses registration requirements related to manure storage areas. The type of manure storage used at a feedlot may affect its potential to pollute surface or ground water. For example, the agency is concerned about the pollution threat that exists at facilities with unlined earth basins. A database that contains records of facilities with a particular type of manure storage such as unlined basins will allow the agency to systematically address and implement solutions to resolve these problems.

Item I contain registration requirements for information on distances from the manure production/storage facility to wells. The potential for well contamination is related to the distance from the well to manure sources. While this circumstance is seldom observed to be a hazard at most animal feedlot, manure storage area and pasture operations, it is part of the level II inventory of the Feedlot Inventory Guidebook, and to maintain consistency between the level II inventory and registration, it is reasonable to include this item as an information requirement.

Item J requires that the name of the person completing the registration be identified. For the ability of the agency to check on the reliability of data it is needed and reasonable to have a provision that allows the agency to contact the person responsible for completing the requirements of registration.

Item K allows the agency to modify the registration form according to environmental priorities. This form will be modified when additional information is needed to assess and better understand environmental problems. The recent concern over regional buildup of air pollutants from concentrated areas of feedlots is an example of a possible shift in environmental priorities.

The modification allowed by this provision is limited to the extent that it allows the agency to add questions seeking additional relevant information to address future feedlot program needs.

To guide this process the agency will use environmental outcome methods in the program plan to identify environmental problems that warrant seeking additional information from livestock operation and manure storage areas. The agency will also collaborate with BWSR to revise the Feedlot Inventory Guidebook to ensure that questions on the registration form and the feedlot guidebook inventories are consistent. For the ongoing usefulness of the registration form, it is needed and reasonable that the agency have the flexibility to make changes that will collect information related to evaluating environmental problems.

Subpart 2 identifies the owners of animal feedlots, manure storage areas and pastures that are subject to registration requirements. They are categorized into two groups as described under items A and B.

Item A states that owners of animal feedlots, manure storage areas and pastures with 50 or more animal units are subject to registration requirements. From an administrative resource and pollution-impact standpoint, the agency does not view it as practical to maintain registration information on animal feedlots, manure storage areas and pastures outside of shoreland below 50 animal units. This threshold is also related to statutory provisions. Minn. Statute 116.07, subdivision 7(g), limits the permitting authority of the agency to feedlots with 50 or more animal units outside of shoreland and to feedlots with 10 or more animal units in shoreland. For consistency and uniformity, it is reasonable for the agency to establish this requirement.

Item B states that owners of animal feedlots, manure storage areas and pastures with 10 or more animal units and less than 50 that are within shoreland are subject to registration requirements. The need and reasonableness for establishing this provision is the same as item A.

Subpart 3 establishes procedures for registering for the registration period ending October 1, 2001. Livestock and manure storage area facility owners must register according to one of three methods as described in items A to C.

Item A sets forth a process for registering whereby a livestock and/or manure storage area owner completes a registration form supplied by the agency and submits it to the commissioner. It requires that the form be submitted by October 1, 2001. This method of registration is needed for owners who are not able to meet registration requirements through methods described under items B and C.

Two aspects related to the registration process must be considered in evaluating the reasonableness of this provision. For the provision to be reasonable there must be reasonable assurances that the agency and county registration program has a system and capacity to reliably provide registration forms to the owners. Also, for the provision to be reasonable, the form must be relatively simple and easy to complete.

As part of the rule revision the agency has prepared a feedlot program plan to implement the terms of the proposed rule. Under that plan the agency has allocated 2.5 full-time equivalent (FTE) to administer the registration program. See page 12 in Exhibit I-4. The plan accounts for all the various duties that must be conducted in order to adequately implement a registration program. In addition the MPCA as well as other agencies are planning information and outreach efforts to educate owners on the requirements of the new rules. These efforts should help familiarize the owners with registration forms and an understanding of how to fill them out. Finally, the proposed rules on delegation require that counties plan and implement a registration program. The combination of these measures by the agencies and the counties should provide reasonable assurance that livestock and manure storage facility owners receive adequate notification and materials to comply with the requirements. Therefore, owner registration by submittal of a form is a reasonable requirement.

The registration form and the completion of it are a factor in the reasonableness of requiring livestock and manure storage facility owners to comply with this provision. As was discussed under subpart 1 the registration form was designed to be simple and easy to use. The proposed registration form is two and one-half pages in length and contains approximately 30 blanks to fill in. See Exhibit I-3. Under most circumstances livestock and manure storage area facility owners will have all the information needed to complete the form at arms-length. The registration form should not take more than 15 minutes to complete. Based on this analysis of practical considerations this provision is a reasonable requirement.

Item B allows a permit application filed by a livestock and/or manure storage area facility owner between the adoption date of the proposed rule and the October 1, 2001 registration deadline to satisfy the registration requirements of this part. The information supplied by a permit applicant on a feedlot permit application form is comprehensive and includes all items of information required for registration under subpart 1. Therefore, the agency already has the necessary information and the owner should not need to be required to submit it again. It is reasonable for the agency to establish procedures that reduce the regulatory burden for parties subject to regulations.

Item C contains conditions under which a county level II or level III inventory satisfies the registration requirement for an owner subject to registration. To preserve the integrity of the registration program the agency requires that a level II or level III inventory meet a set of specific requirements. These requirements are set forth in subitems (1) to (4).

The agency registration program has been designed so that owners in counties with level II or level III inventories that meet the criteria of this part are considered to have met registration requirements. It exempts livestock and manure storage area facility owners in counties with eligible level II or level III feedlot from having to complete and submit a registration form. The agency is proposing this feature of registration as a way to reduce the regulatory burden for owners. It allows the owners to save the work and inconvenience of having to submit a registration form. The level II or level III inventory option may affect owners in as many as 21 counties since this is the number of counties that have done these inventories. Approximately, 40 counties will have completed level II or level III inventories by 2001. See Exhibit C-5.

Because of the work reduction for the agency as well as regulated parties this feature of the proposed registration requirement is reasonable.

Subitem (1) sets forth the first of four criteria that must be met in order for a level II or level III feedlot inventory to satisfy the registration requirement. It requires that in order for an inventory to be used to satisfy registration requirements it must meet at least the level II criteria of the Feedlot Inventory Guidebook.

The level II information items in the Feedlot Inventory Guidebook match the information requirements listed in item A and items E to J of subpart 1. See Exhibit I-1. This provision is needed is to provide specificity so that a clear link is established between each information item in the Feedlot Inventory Guidebook and each information item under subpart 1. As was discussed under section titled “The role of the Feedlot Inventory Guidebook and the roles of inventories” in subpart 1, information submitted on inventories to the agency by counties can vary. By clearly identifying the information items in subpart 1 that must be present in the level II inventory and including the required supplemental information, the counties are relieved of any uncertainty as to whether their inventory procedure and content is meeting registration requirements.

Subitem (2) requires that in order for a level II inventory to be used as the basis to satisfy registration requirements it must have been conducted subsequent to October 1, 1997. This requirement is needed to ensure that registration information obtained from inventories will be current to within four years. The SONAR under subpart 1 explains that in order for registration information to be useful to the feedlot program, it must be reasonably up-to-date.

Subitem (3) requires that in order for a level II inventory to be used to satisfy registration requirements it must contain information according to subpart 1, items B to item D. Subpart 1, items B to D are information requirements related to owner name, owner address, and feedlot location. While feedlot inventories may contain this information, a level II inventory, according to the Feedlot Inventory Guidebook, does not require this information to be listed. Therefore, this information criteria must be made a requirement in order for a level II or greater feedlot inventory to satisfy the requirements of registration.

Subitem (4) requires that in order for a level II or greater inventory to be used to satisfy registration requirements it must be submitted to the commissioner. This requirement is needed to provide documentation that registration requirements for owners identified on the inventory have been met through a level II inventory. Submittal to the agency of level II inventory information should not be a difficult or time-consuming task. Delegated counties are already accustomed to this practice in order to meet feedlot grant application requirements.

It should be noted that counties will need to submit level II inventories on an on-going basis in order for animal feedlot, manure storage area and pasture operation owners identified on the inventory to meet registration update requirements. This needs to be done because, under subpart 4, owners are required to update their registration on four-year intervals.

The consequence of counties failing to meet at least the level II requirements of this provision depends on whether or not a county is delegated. Delegated counties are required by the proposed rules on delegation to submit registration information to the agency on an annual basis. Therefore, they are responsible for ensuring that level II inventories are submitted to the agency in accordance with this provision. Failure by non-delegated counties to submit level II inventories according to the terms of this provision will result in the obligation of the owner to individually register.

Subpart 4 establishes a registration program for the time period after October 1, 2001. Item A provides registration terms and conditions for livestock and manure storage facility owners who were not registered prior to October 1, 2001. Depending on their status they are divided into one of two groups as identified in subpart 4, item A, subitems (1) and (2).

Subitem (1) states registration procedures that are required for owners that commence operations and that are not required to submit a permit application. Under the proposed permitting system livestock and manure storage facility most owners with less than 300 animal units will be able to commence operations without applying for a permit. It is necessary to have a procedure that describes the registration process that applies to these facilities. As explained in subpart 3, item A it is reasonable to require this group of livestock and manure storage facility owners to submit information to the agency on a form that is provided by the agency.

Subitem (2) states registration procedures required for livestock and manure storage facility owners that submit a permit application prior to commencing operations. Under the proposed permitting system livestock and manure storage facility owners with more than 300 or more animal must apply for a permit application. It is necessary to have a procedure that describes the registration process that applies to these facilities. As explained in subpart 3, item B, it is reasonable that submittal of permit application satisfies the registration requirement.

Subpart 4, item B addresses registration requirements for the period of time subsequent to October 1, 2001. Under this provision an on-going registration program consisting of four-year cycles is established. It means the registration program will complete a cycle every 4-years. For example, the registration period following October 1, 2001 will complete October 1, 2005 and the registration period subsequent to October 1, 2005 will complete October 1, 2009. All livestock and manure storage facilities must register within each 4-year period.

The agency's purpose for proposing on-going registration is that the registration data must be accurate and timely in order for it to be useful. The agency intends to use the information to prioritize high-risk feedlots, to support a communication and outreach plan, and to contribute to developing agency regulatory strategy. All of these uses depend on accurate and up-to-date data. Therefore, on-going registration is a necessary component of the registration program.

The 4-year time frame ensures that the data collected is kept reasonably current. It's important to note that registration may be accomplished at any time during a 4-year period. The intent of this design is so that the registration program can be conducted in a reasonable manner. It allows the county feedlot programs and the agency to spread out the workload required to implement the program. This enables the agency and the counties to maintain consistent staffing levels to support their operations. Therefore, this design feature of the registration program constitutes a reasonable approach for conducting feedlot regulatory activity.

Subitem (1) contains procedures for registering livestock and manure storage areas for the time period after October 1, 2001. It addresses livestock and manure storage area facility owners who must submit a registration form or who submit a permit application to the commissioner or delegated county. It states that owners subject to this provision must use the procedures as identified under subpart 4, item A, subitems (1) and (2). The SONAR for this part is the same as for subpart 3, items A and B.

Subitem (2) lists the criteria that a level II or level III inventory must meet in order for a livestock or manure storage area facility owner to use this option to satisfy registration requirements. As explained in this SONAR for subpart 1, the agency registration program has been designed so that owners in counties with level II or level III inventories that meet the criteria of this part are considered to have met registration requirements if the owner participates in the level II or level III inventory, and the supplemental information in subitem (2)(b) is included.

Subitem (2), units (a) to (d) contain the requirements necessary for a level II or level III inventory to satisfy registration requirements. They are identical to the provisions in subpart 3, item C, subitems (1) to (4) with two exceptions. One exception is that the provisions apply to the registration time period after October 1, 2001. The second exception is that subpart 1, item K has been added as an information requirement. Subpart 1, item K allows the agency to alter the information requirements when a shift in environmental priorities has been demonstrated. In order for a level II or level III feedlot inventory to satisfy the registration information requirements of subpart 1, after October 1, 2000, it must contain subpart 1, item K.

Subpart 5 sets forth the agency's enforcement terms for livestock and manure storage area facility owners that do not meet registration requirements. The provision identifies a penalty as an enforcement option that the agency may use for owners who are subject to registration but are not in compliance with registration requirements. Under the provision the penalty is applicable for each four-year period in which the owner has been subject to the registration requirement but has failed to register.. The agency's authority to conduct enforcement actions for violations of pollution rules and regulations is established in Minn. Statute 115.071.

The agency bases the need to explicitly state the enforcement authorities for this provision on practical considerations. Registration will be a high profile component of the feedlot program. It will apply to the vast majority of livestock and manure storage area facility owners in the state. As a result the number of violations will be large even if a small percentage don't comply with the registration requirement. Under these circumstances the agency must be ready to respond with clarity to non-compliance. This provision is an initial step to providing that clarity.

The alternative is for the agency to be silent about its authority to enforce the registration requirement. The ramifications of this approach may help explain the necessity of the proposed provision. To successfully implement the registration program the agency must rely on the motivation and willingness of the owners to comply. If registration compliance is not supported by enforcement and a small segment, let's say 20 percent, perceive that registration is not viewed as significant, it will put a tremendous burden on the agency to get that group to comply. It will diminish the motivation of those subject to the requirement and the agency will have to work harder to accomplish the goals of registration.

On the other hand, if the agency actively moves forward on enforcement without adequate advance notice, it will surprise those who fail to register. They will claim that they were unaware of enforcement consequences and the agency will be faced with a host of objections. Responding to these challenges will consume agency resources and divert it from more productive efforts.

Under either one of the above scenarios, failure to be clear regarding enforcement of registration will have detrimental consequences for the agency to be able to conduct its business. It is needed and reasonable for the agency to establish provisions that will protect the agency's ability to effectively conduct normal and routine operations.

Finally, while the proposed provision clearly sets forth an intention of the agency to consider enforcement for registration non-compliance, the provision does not make a penalty mandatory nor does it stipulate a penalty amount. The language is flexible and it allows those responsible for enforcement a choice in employing its authority. Thus, the flexibility provided in the terms of the provision constitutes a reasonable approach to addressing this aspect of the registration requirement.

Permit Program

As discussed in the Statement of Reasonableness as a Whole, there are many possible ways to regulate animal feedlots, manure storage areas and pastures. The agency has in the past chosen to regulate them primarily through issuing permits and certificates of compliance. Permits were required when construction was proposed at an animal feedlot or manure storage area. Along with the permit, the facility that applied for the permit might be inspected at some point before, during, or after the construction was completed. Inspections and outreach have not been a significant part of the strategy for regulating animal feedlots, manure storage areas and pastures. The proposed rules and draft feedlot program plan (Exhibit I-4) place much greater importance on outreach, education and inspections that in the past. This part discusses the reasonableness of each part of the proposed permit program.

<u>7020.0400 Permits and Certificates Issued Prior to the Effective Date of this Part</u>

This part establishes the status of permits and certificates of compliance issued prior to the effective date of this proposed rule. The proposed part defines and describes each of permit and certificate types previously issued to ease the potential confusion over the many types of documents that have been issued by the agency or delegated counties over the last twenty years.

Subpart 1. This proposed provision contains the requirements for owners holding SW-A permits to comply with parts 7020.0400 to 7020.0535 and obtain a new permit, if required under these parts. The permit application will then be reconsidered by the agency or delegated county pursuant to these parts and Minn. R. ch. 7001. This provision requires these owners to comply will all parts of this chapter upon it's effective date. This provision is needed because some SW-A permits did not include any expiration date and are therefore are still in effect. Since many of these permits probably don't accurately represent the facilities to which they were issued, it is reasonable to require owners to obtain a new permit, if required, and to register in accordance with part 7020.0350. The current rule states under part 7020.0600 that "(t)he conditions and provisions of all agency animal feedlot permits issued under Minnesota rules SW 51 to 61 before December 25, 1979, shall continue to be in effect. Upon application for a change in operation or change of ownership of an existing, permitted animal feedlot, the permit shall be reconsidered pursuant to these parts." This does not clarify the status of permits issued to owners that never apply for a permit modification. For this reason, it is reasonable to clearly state that owner holding these permits must comply with this part on the effective date of this part.

Subpart 2. This provision requires an owner having certificates of compliance to comply with the permitting requirements of these parts. This includes registering in accordance with part 7020.0350, applying for permits as applicable and conforming to the technical standards in parts 7020.200 to 7020.2225. This is reasonable because many owners may consider that they are in compliance by having been sent the certificate of compliance letter, when they most likely will be required to comply with additional requirements compared to what was required at the time the certificate of compliance was issued. One example is the requirement to develop a manure management plan according to part 7020.2225, subp. 4.

Subpart 3. Interim A (issued for construction activities under the current program) and Interim B (issued for correction of a pollution hazard under the current program) are issued with expiration dates no longer than 10 months from the date of issue. The proposed rules will allow interim permits that were issued prior to the effective date of the proposed rule to expire on the date stated in the permit. The issue to be addressed within the proposed rules is for interim permits that have been issued but the work authorized and/or required under those permits has not been completed by the expiration date of the permit.

The proposed rules treat construction short-form, SDS and NPDES permits like Interim A permits of the existing rule. Any of these permits can authorize construction and expansion at an animal feedlot or manure storage area. Therefore, it is reasonable to require the owner that was issued an Interim A permit for construction under the existing rules and that has not been completed by the expiration date of the permit to apply for a construction short-form, SDS or NPDES permit, which ever is applicable.

The proposed rule treats interim permits (as defined in proposed rule part 7020.0300, subp. 13) like the Interim B permits issued prior to the effective date of the proposed rule. Interim B permits are those that are issued to correct a "potential pollution hazard." Under the proposed rules, interim permits will be issued to "pollution hazards." The proposed rules also replace the term "potential pollution hazard" with "pollution hazard." The proposed rules will require owners that were issued an Interim B permit and have not completed the work authorized and required under the permit to follow the requirements under part 7020.0535, subp. 5. Part 7020.0535, subp. 5 establishes the requirements for owners issued an interim permit under the proposed rule that have not completed the work required under the interim permit. The reasonableness of part 7020.0535, subp. 5 is discussed in detail under that part of this Statement of Need an Reasonableness. Given the similarity between the proposed interim permits and Interim B permits issued prior to the effective date of the proposed rule, it is reasonable to requires owner that have not completed the requirements under and Interim B permit to follow the requirements of 7020.0535.

Subpart 4. This subpart states that status of any NPDES or SDS permit prior to the effective date of this part is unaffected. Those permits will expire in accordance with the terms and conditions of each individual permit. While the proposed rule clarifies who is required to apply for an NPDES or SDS permit, it does not change any conditions, requirements, or permitting processes for owners subject to specific permit requirements. It is reasonable to clearly state this in the proposed rules.

<u>7020.0405 Permit Requirements</u>

Subpart 1. This part of the proposed rule establishes the types of permits that will be issued by the agency; some of these permits will also be issued by delegated counties. This part also establishes which type of permit for which owners of animal feedlots or manure storage areas that are in certain categories must apply. This part also identifies the owners of certain animal feedlots, manure storage areas and pastures that are not required to apply for a permit and the processes to be followed when ownership of a permitted facility changes.

There are four type of permits that will be issued by delegated counties and/or the agency. These are: National Pollution Discharge Elimination System (NPDES) permits, State Disposal System (SDS) permits, construction short-form permits, and interim permits. As stated above, the proposed rules are intended to require permits for only those owners of animal feedlots or manure storage areas that:

- Are required to obtain a permit under federal requirements;
- Have 1000 animal units or more and are not required to obtain a permit under the federal requirements;
- Are designated a pollution hazard;
- Are proposing to construct or expand and are of sufficient size so as to have a significant potential to be objectionable to local residents; and/or
- Are proposing a construction or operating methods that are unique and need further evaluation from the agency.

Item A. This item states that an owner shall apply for a NPDES permit if the facility meets the criteria for a Concentrated Animal Feeding Operation (CAFO). The Minnesota statutory amendment states that animal feedlots with 1,000 animal units or more must apply for and obtain an NPDES permit. The requirement to obtain an NPDES permit for all animal feedlots with more than 1,000 animal units as written in the federal regulations is an issue undergoing further review by the EPA.. Some argue that the requirement to obtain a NPDES permit applies only to those with more than 1,000 animal units that also discharge or have discharged. The focus of EPA's further review is to clarify which facilities having 1000 animal units or more have the potential to discharge and are therefore required to obtain a NPDES permit. Minn. Stat. § 116.07, subd. 7c, clarifies what facilities must obtain an NPDES permit, at least for Minnesota. Any animal feedlot with 1,000 or more animal units is required to apply for and obtain a NPDES permit. Therefore, it is reasonable to propose that the owner of any animal feedlot that meets the definition of CAFO must apply for an NPDES permit.

The proposed rules also state that manure storage areas that meet the definition of CAFO must apply for a NPDES permit. The US EPA, Office of Waste Management stated in Guidance Manual and Example NPDES Permit for Concentrated Animal Feeding Operations, Review Draft, August 6, 1999. See Exhibit P-2. "The NPDES permit regulations [40 CFR 122.23(b)(1)] give the permitting authority (EPA or NPDES-authorized States) considerable discretion in applying the AFO definition. EPA defines the AFO to include the confinement area and the storage and handling areas necessary to support the operation (e.g., waste storage areas)." It is reasonable to include manure storage areas in the category required to apply for a NPDES permit since the pollution threat at a facility is associated with the manure produced or stored at a facility and not solely by the animals themselves.

Finally, it should be noted here that all NPDES permits issued by the agency for animal feedlots and manure storage areas will be a combination NPDES/SDS permit. This is consistent with the agency's current practice for feedlot NPDES permits and is needed and reasonable to allow the agency to address issue outside the regulatory framework of the federal regulations which address only surface water issues. Some of the specific issues that the agency has addressed under SDS and NPDES/SDS permits are described in more detail in this SONAR under subpart 1, item B, subitem 1. The agency is also currently working on a draft general NPDES/SDS permit that may apply to the majority of CAFOs in the state.

Subitem 1. This subitem states that an owner shall apply for a SDS permit if the facility has the capacity to hold 1,000 or more animal units or the manure produced by 1000 or more animal units and is not a CAFO. As stated in the statement of reasonableness for 7020.0405, subp. 1, the federal requirement under 40 CFR 122.23 for all animal feedlots with more than 1,000 animal units is under further review and discussion. It is anticipated that at some point in time, the federal requirement for all animal feedlots with more than 1,000 animal units will be legally challenged. If the legal challenge is successful and the federal requirement then becomes that only facilities that have had a discharge or are currently discharging are required to obtain an NPDES permit, the agency will have the SDS permit to issue to these facilities. This is consistent with Minn. Stat. § 116.07, subd. 7c, and the agency's policy that any animal feedlot or manure storage area with 1,000 or more animal units must apply for and obtain an operating permit. If the proposed rule did not include the requirement included in this subitem, these facilities would not be required to obtain any state or federal feedlot permit.

In addition, the agency intends to use the SDS permit as it has under the current program to address program issues which the federal regulations do not cover under an NPDES permit program. These include:

- Potential impacts to ground water from owners of animal feedlots and manure storage areas operations, manure storage areas and land application activities. The agency currently issues SDS permits for other large industrial and municipal waste facilities to protect ground water from waste storage and land application;
- Air quality issues such as odor and air emissions. The agency has included provisions for addressing air quality issues in SDS and interim permits under the current program. In addition, the proposed rule requires owners having 1000 animal units or more to develop and implement an air emissions plan (part 7020.0505, subp. 4, item B, subitem 1.
- Need to provide an opportunity for public notice and feedback on facilities having a comparable animal unit size and potential to impact neighbors. The opportunity for public input should not be limited to surface water issues like the federal NPDES permit program.
- Incorporation of site or facility-specific provisions into the permit to address mitigation measures in an environmental impact statement or to obtain a negative declaration in an environmental assessment worksheet (EAW). Following the Environmental Quality Board's recent revisions to Minn. R. ch. 4410. More feedlot facilities will likely undergo environmental review in the future and therefore more facilities may need site specific conditions incorporated into their permit.

The agency may also realize some reduction in administrative burden if a large number of facilities having 1000 animal units or more attempt to demonstrate that they are not a CAFO and request that they do not need a NPDES permit. The SDS permit process (general or individual) may save significant staff review time on these requests and minimize contested case requests by having essentially the same requirements as the NPDES/SDS permit. Finally, since the pollution threat at a facility having 1000 animal units or more is primarily associated with the pollutants in the manure produced or stored at a facility, no measurable distinction between the potential for pollution from these facilities and CAFOs exist. For these reasons, it is reasonable to require any animal feedlot or manure storage area with 1,000 or more animal units that has been determine to not be a CAFO to apply for a SDS permit.

Subitem 2. This proposed subitem requires that any facility that has been determined to be a pollution hazard that can not be, or has not been, corrected under an interim permit to apply for a SDS permit. This is one possible course of action to be taken if an owner fails to fulfill all parts of an interim permit that has been issued to correct a pollution problem. A key difference in the interim permit and SDS permit for addressing pollution problems is that the SDS permit is placed on public notice and is subject to public comment. If the problem is such that it cannot be resolved in the 24-month period allowed under the proposed interim permit, it is significant enough that the interested parties should have the right to be informed of the action and given the opportunity to comment on the problem and proposed solution. Another course of action for the agency could be to proceed with an enforcement action. The course of action taken will depend upon several factors including the apparent level of effort that the owner made to comply with the permit conditions. For these reasons, the proposed requirements of this subitem are reasonable.

Subitem 3. This proposed subitem requires the owner that is proposing an alternative construction or operating method other than those established in the technical standards to apply for a SDS permit. This proposed subitem also requires the owner to hold a SDS permit for alternative operational methods as long as those operational methods are employed. As discussed in the Section IV(A), *Reasonableness as a Whole*, one reason for incorporating the technical standards into the proposed rules is to reduce or eliminate the need for issuing permits to some facilities. The technical standards are the minimum location, construction and operating requirements for animal feedlots, manure storage areas and pastures to minimize the environmental impact of these facilities. It is not the intent of the agency to limit the construction and operating methods that have been developed or may be developed in the future that achieve the same environmental goals. For this reason, it is reasonable to allow an owner to use those methods that the owner can demonstrate to the commissioner that the proposed method is at least as protective of the environment. Since the methods that will be proposed by the owner will be different from what the agency has thoroughly reviewed and are incorporated in this proposed rule, it is reasonable to require the owner to apply for a permit in which the proposed project undergoes a more thorough review by agency staff and is placed on public notice and subject to public comment. This process is different form the variance process provided under part 7020.0505, subp. 6, which presents and opportunity for owners to avoid hardship by proposing construction or operational methods that are less protective than the technical standards in this rule.

This subitem does not allow an owner to obtain a SDS permit as an alternative to the locational requirements in parts 7020.2000 to 7020.2225. These requirements, such as setback distances, locating in shoreland, a floodplain, proximity to sinkholes and separation distance to bedrock, etc., are not intended to be exempted or varied by the requirement for an SDS permit. Since there is nothing that can achieve an equivalent environmental result as not locating in an environmentally sensitive area or area in which a failure of a system (e.g., liquid manure storage area located over shallow bedrock) can quickly and significantly damage the state's water resources, it is reasonable to exclude the locational requirements from these provisions, and restrict application of this subitem only to construction and operating methods.

Subitem 4. This proposed subitem requires the owner that is proposing to construct or expand an animal feedlot or manure storage area for which conditions other than those established in the technical standards were assumed: such as a mitigation measure in an environmental impact statement or in obtaining a negative declaration in an environmental assessment worksheet must apply for a SDS permit unless required to apply for a NPDES permit. As discussed below in this SONAR for parts 7020.0505 and 7020.0535, the proposed construction short-form and interim permits are not subject to the public notice and comment require as are NPDES and SDS permits. Interim permits under the current rules are not subject to the public notice and comment requirements. The reason for excluding construction short-form permits from the public notice and comment requirements is primarily to streamline the permitting process. This is reasonable because essentially all conditions that will be placed into a construction short-form permit are included in the rule and will, therefore, be open to public comment during this rulemaking. Since a construction short-form or interim permit is issued in accordance with Minn. R. ch. 7001 and 7020, these permits are subject to the provisions under which an interested party can request a contested case hearing over the issuance of the permit; this protects an interested person's ability to participate in the permitting of that facility. However, construction short-form and interim permits are not required to be noticed as broadly as SDS and NPDES permit actions. For example, NPDES and SDS permits are noticed, while construction short-form and interim permits are not required to be noticed. If an environmental impact statement or an environmental assessment worksheet negative declaration requires measures that are something other than what is required under the proposed rules, all interested parties should have an opportunity to be notified of the measures and have the opportunity to provide comments. The NPDES and SDS permit processes provide these opportunities: construction short-form and interim permits do not. For this reason, the proposed subitem is reasonable.

Item C. This proposed item requires the owner of a animal feedlot, manure storage area or pasture that has been determined to be a pollution hazard to apply for an interim permit unless the owner is required to apply for a SDS or NPDES permit. This is the same function as the Interim B permits have under the current rule.

Item D. This proposed item requires the owner of a animal feedlot or manure storage area with 300 to 999 animal units that is proposing to construct or expand in accordance with the proposed technical standards to apply for a construction short form permit unless the owner is required to apply for a SDS or NPDES permit. This is the similar to the function the Interim A permits issued under the current rule. A primary difference between Interim A and construction short-form permits is that the owner issued a construction short-form permit is constrained to only those location, construction and operating methods established in the technical standards and no such constraints exist under the current Interim A permits. For purposes of public participation and informing interested parties, it is reasonable to clearly limit the application of the construction short form permit to activities specified in the technical standards. This proposed item also states that owners that have been determined to be a pollution hazard must apply for an interim permit even if the owner is planning an expansion. This is reasonable because a condition of interim permits is that no expansion can be stocked with animals prior to correction of the pollution hazard.

Subpart 2. This proposed subpart states that no owner that is required to apply for a permit under these proposed rules may expand prior to obtaining that permit. Expansion, as defined in 7020.0300, subp. 11a states that expansion "means construction or any activity that has resulted or may result in an increase in animal units at an animal feedlot or an increase in storage capacity of a manure storage area that is not located at an animal feedlot." This means increasing the capacity of the facility to hold animals or animal manure; not merely increasing the number of animals at the facility, which may fluctuate significantly over time. In addition to expansions, this provision includes construction of a new animal feedlot or new manure storage area where none previously existed. This subpart is intended to state as clearly as possible that if a permit is required, it must be obtained prior to beginning the construction associated with the expansion. It is reasonable to require the owner to obtain the permit prior to construction or expansion because the owner may be required to submit additional information for agency or delegated county review necessary to determine compliance with applicable rules. This is also reasonable because until the permit is issued, the public retains the opportunity to request, for example, a contested case. If this occurs, it is in all parties best interest that construction not commence until the contested issues are resolved.

This subpart also states that stocking an expansion at an animal feedlot, manure storage area or pasture that has been determined to be a pollution hazard is prohibited until the pollution hazard has been completely corrected. This is needed to ensure that the existing problems are resolved prior to creating the potential for additional manure-related pollution problems. If left unresolved prior to expansion, the expansion may or likely would exacerbate the problem. The agency is taking a preventative approach by ensuring proper operation prior to creating a greater potential for manure-related problems. This is an effective and reasonable means of ensuring that pollution hazards are corrected.

Subpart 3. This subpart identifies the owners that are not required to apply for a permit under these parts. Item A states that no permit is required for facilities meeting the requirements of part 7020.2003, subparts 4 to 6. More specifically this applies to feedlots if the facility:

- Has fewer than 300 animal units;
- Has runoff from at least one open lot and the facility is not a CAFO or maintain an imminent threat to humans or the environment;
- Is not a new animal feedlot;
- Owner has registered with the agency or delegated county; and
- Owner has agreed to the compliance schedule for achieving compliance with part 7050.0215 for all open lots at the facility.

This item is intended to clearly state that the estimated 8,000 to 12,000 animal feedlots in Minnesota that are under 300 animal units with open lot runoff are not required to apply for a permit provided they comply with part 7020.2003, subparts 4 to 6. As discussed in Section IV(A), Reasonableness as a Whole, the most efficient means to deal with a large number of regulated facilities such as this is through rules rather than issue individual permits to each of them. All eligible animal feedlots are, by definition, similar and therefore, it is reasonable to regulate them similarly and in fact as a unit. The proposed rules do this and as such permits for each of these facilities are unnecessary. Given the large number of small animal feedlots with open lot runoff, it is reasonable to regulate them in the most efficient means available and therefore to not require the owners of this large, but narrowly defined group, to apply for permits.

Items B and C. These proposed provisions state that no permit is required if: the facility in question is a pasture that that has not been identified as a pollution hazard; or the facility in question is only a short-term stockpile site that is not owned by an owner of an animal feedlot or manure storage area. Both pastures and short-term stock piling sites are subject to the technical standards. If the person responsible for the site complies with these requirements of the technical standards, the risk of ground or surface water contamination is small. If the technical standards are not complied with, the site can be determined to be a pollution hazard and a permit is then required. Enforcement action is also an option available to the agency or delegated county. Since these present a reduced threat to the environment, it is reasonable to not require the owner to apply for a permit.

Subpart 4. This proposed subpart establishes the procedures to be followed by owners when a feedlot or manure storage area is sold or otherwise goes through a change in ownership. Under item A, this subpart states that owners holding an NPDES or SDS permit must submit a complete application for permit modification. This is reasonable because it is required under the existing feedlot rules and is therefore consistent with current practice.

Under item B, the proposed rule requires the owner to submit the change in ownership information on a form provided by the commissioner. This is intended to provide a simplified process and to minimize administrative burden on owners of facilities and on the agency and delegated counties by reducing the processing of permit applications. This is reasonable because it is an area that has not resulted in significant environmental protection or improvement under the current program and will allow all parties to focus more on actual pollution prevention and reduction activities. .

7020.0505 Permit Application and Processing Procedures

This part of the proposed rule establishes the minimum requirements for all permit applications for animal feedlots, manure storage areas and pastures and identifies the processing requirements for those permit applications.

Subpart 1. In subpart 1, the agency proposes that only complete permit applications will be processed by the permitting authority (i.e., delegated counties or the agency). Subpart 4 of this part establishes the minimum content requirements of an application. Subpart 4 contains the permit application content requirements for documentation that the owner has notified local governing bodies (required for any construction under part 7020.2000, subp. 5) and local residents (required for the construction or expansion of any animal feedlot or manure storage area larger than 500 animal units under part 7020.2000, subp. 4). These two notification requirements are needed to ensure local awareness of projects that may affect them. Minn. Stat. § 116.07, subd. 7a, requires neighbor notification of proposed construction or expansion of facilities with 500 or more animal units. The proposed notification required under part 7020.2000, subp. 4 is intended to meet that statutory requirement. Further discussion of the details of these notifications is in the Statement of Reasonableness for part 7020.2000, subparts 4 and 5. Since many of the issues regarding the permitting of animal feedlots, manure storage areas and pastures are directly related to land use and the proximity of these facilities to local residents, it is reasonable to ensure that local residents and governing bodies are aware of a project.

Staff experience suggests that owners often fail to notify local residents and governing bodies of plans to construct or expand an animal feedlot or manure storage area. If the permit application process requires the owner to submit evidence of complying with the required notifications and the permitting authority does not act on incomplete permit applications, the owner has a greater incentive to comply with these requirements. For this reason, it is reasonable to not act on permits that are incomplete.

Item A. This item states that all SDS and NPDES permit application must be submitted to the commissioner with a copy going to the county feedlot pollution control officer. Since the agency is not allowed to further delegate the processing of NPDES permits to delegated counties and the administrative and logistical problems of delegating counties to issue SDS permits is too great at this time, these applications must be processed by the agency. The option to allow delegated counties the ability to issue SDS permits was considered and rejected due to the fact that the county processes for issuing these permits would have to be equivalent to the agency processes including all the public notice and hearing requirements. It was staff's opinion that very few counties have the resources and abilities to undertake this process for more than a small number of facilities. For these reasons, it is reasonable for the proposed rules to require all SDS and NPDES permit applications to be submitted to the commissioner for processing with copies going to counties so the county feedlot pollution control officer is aware of proposed activities. It is also reasonable to require owners to submit a copy of the permit application to the delegated county because the local feedlot officer can likely better assist the owner in completing the necessary application requirements and provision insight to local issues that may affect the proposed project. The agency foresees that owners could submit the application directly to the delegated county and the county feedlot officer would them forward the application to agency with comments and recommendations. This process is essential to the coordinated effort between the agency and delegated counties.

Item B. This item states that Interim and construction short-form permit applications may be submitted to the commissioner or county feedlot pollution control officer at the owners discretion. The current rule also allows owners to submit applications for interim permits to the commissioner or county feedlot pollution control officer, at his/her discretion. As stated in Section IV, Reasonableness as a Whole, a goal of the proposed rule is to streamline the permitting process and to shorten the time that is needed to issue a permit. The proposed construction short-form permit is intended to do this. One means of shortening the time to issue a permit is to allow counties to issue them. Counties have, in the past been able to issue interim permits much more quickly than the agency in most cases. For these reasons, it is reasonable for the proposed rule to allow construction short-form and interim permit applications to be sent to the commissioner or county feedlot pollution control officer at the owners discretion.

Subpart 2. This subpart establishes the schedules and timelines for submitting a permit application. Item A establishes the schedule by which the owners of CAFOs and animal feedlots or manure storage areas with 1,000 or more animal units must submit an application. Minn. Stat. § 116.07, subd. 7c(a)(3), provides "after January 1, 2001, all existing feedlots with 1,000 or more animal units must be issued an individual or general National Pollutant Discharge Elimination System permit." Considering the magnitude of the effort that will be required to accomplish processing permits for this group by January 1, 2001, the application deadline of June 1, 2000, is reasonable.

Item B. This item establishes the timeline by which the owners of animal feedlots, manure storage areas and pastures that have been determined by the commissioner to be a CAFO in accordance with EPA guidelines and agency policy, October 12, 1999, memorandum from G.

Pulford to G. Wegwart) must submit permit applications. The proposed rule requires the owner to submit the application within 30 days of a written order of the commissioner. See Exhibit P-3.

The agency anticipates that when an animal feedlot, manure storage area or pasture has been determined be a significant pollution source, it will attempt to seek the owner's cooperation to obtain a timely resolution and elimination of the pollution problem. This process may include issuance of an interim permit, which is the tool most frequently used by the agency if the matter can be resolved within a short time period. The process could also include the use of other tools such as notice of violation or, if necessary, escalating enforcement tools such as an administrative penalty order. In any case, a variety of tools are available and one such tool is the NPDES permit if the facility is designated a CAFO. If the designation process is used, the MPCA staff will contact the owner and conduct an on-site inspection. During the inspection, MPCA staff will be able to apprise the owner of the issues of concern. As early as that time, the owner can begin anticipating corrective actions and planning for them. At the end of the designation process, the MPCA will notify the owner of the decision and, from that point, the owner will have a minimum of 30 days to submit the appropriate application. With the advance contacts with the MPCA and the intervening time period between the inspection and the MPCA's decision, 30 days after the MPCA's notice should be sufficient time to collect the required information and prepare and submit the application. MPCA also needs to balance the fact that the facility is a significant pollution source and timely resolution is needed. For these reasons, it is reasonable to require the submittal within 30 days of the notice of the MPCA's CAFO determination.

Item C. This item establishes the timeline under which an application for a new animal feedlot or manure storage area that is required to apply for a SDS or NPDES permit must be submitted. This proposed item requires submittal 180 days prior to the planned date of commencement of construction. This timeline is intended to allow enough time for the agency and owner to address all issues so the permitting process does not result in a delay of the commencement of construction. It is reasonable to attempt to minimize any construction delays caused by the permitting process.

Item D. This item establishes the timeline under which an application for a new animal feedlot or manure storage area that is required to apply for a construction short-form permit must be submitted. This proposed item requires submittal 90 days prior to the planned date of commencement of construction. Since construction short-form permits will be able to be issued much quicker than SDS or NPDES permits, it is believed that 90 days will be sufficient time for processing. This timeline is intended to allow enough time for the agency and owner to address all issues so the permitting process does not result in a delay of the commencement of construction. It is reasonable to attempt to minimize any construction delays caused by the permitting process.

Item E. This item establishes the timeline under which an owner of an animal feedlot, manure storage area or pasture that has been determined to be a pollution hazard must submit an application. As discussed in the Statement of Reasonableness, the definition of "pollution hazard," covers numerous fact situations. These situations can range from a facility with a small and infrequent amount of runoff from an open lot that needs to be addressed but is not an immediate threat to an incorrectly installed liquid manure storage area that discharges large amounts continuously and therefore must be addressed immediately. The proposed rule requires the owner to submit an application for an interim permit as required by the commissioner or county feedlot pollution control officer but the owner has at least 15 days after receiving a written request to submit the permit application. Staff estimate that fifteen days is the minimum amount of time needed to produce a complete application. Since there is a wide a range of conditions that could be designated as a pollution hazard, and the need to submit an application should be adjusted to reflect the immediacy of the problem, it is reasonable to allow the commissioner or county feedlot pollution control officer flexibility to adjust that timeline to fit the specific facts of each situation.

Subpart 3. The agency proposes that applications must be submitted on a form provided by the commissioner. For reasons of consistency and ease of processing, it is reasonable to require applications to be submitted on a standard form.

Subpart 4. The agency, through subpart 4, establishes the minimum contents of a permit application. Item A establishes the minimum information that is required of all facilities applying for any permit. The information required is the minimum information upon which a reasonable, considered permitting decision can be based. The majority of the information contained under this item is required under the current rule under part 7020.0500, subp. 2. Subitems 1, 3, 4, 5, 7, 8, 9, and 12 are restatements and clarifications of the requirements of the current part 7020.0500, subp. 2.

Subitem 2 requires the applicant to state the legal name and address of the business if it is different than that of the information required in subitem 1. Since businesses can have complex ownership arrangements, the owner(s) are not always on-site resident owners and all owners are ultimately responsible for the facility’s compliance, it is reasonable to require this information in any permit application.

Subitem 6. Subitem 6 contains the agency's proposal for implementation of the other rule provisions. requires a list of all existing and proposed manure storage areas including all existing and proposed liquid manure storage areas and permanent stockpile sites and plans for proposed liquid manure storage areas. The current rule requires plans for liquid manure storage areas larger than 500,000 gallons. As discussed in the Statement of Need, the environmental impact of manure can be significant. Failure of a liquid manure storage area has the potential to make local waters unfit for consumption and/or unable to support fish. For this reason, it is reasonable to require the identification of all storage areas including all liquid manure storage area and permanent stockpile site plans with an application.

Subitem 10. Subitem 10 contains the agency's proposal that owners subject to the requirement to apply for a NPDES or SDS permit must include manure management plans with the application. The current rule requires all applications to include a manure management plan. Animal feedlots and manure storage areas that are required to apply for a NPDES or SDS permit are large facilities that generate a large quantity of manure. These are the facilities that could have the greatest difficulty finding enough acreage on which to apply the manure and the impact of misapplying a large quantity of manure can be significantly greater that the quantity of manure generated from a small facility. In an effort to streamline the permitting process and to require no more paper from applicants that what is needed and will be reviewed by the permitting authority, the proposed rules excluded construction short-form and interim permits from the requirement to submit the manure management plan with the application. The proposed rules still allow the permitting authority to require the owner to submit the manure management plan with the application under subitem 12. The proposed rules (part 7020.2225, subp. 4) also require all animal feedlots and manure storage areas with more than 100 animal units to prepare and maintain a manure management plan. For these reasons, it is reasonable to require only those owners that are required to apply for a NPDES or SDS permit to submit this plan with an application.

Subitem 13. The agency proposes in subitem 13 to require owners that are required to obtain a NPDES permit to submit the additional form by US EPA for NPDES permit applications, NPDES form 2B. See Exhibit P-7. In an effort to streamline the proposed rule and permitting structure, the agency anticipates having a single application form for NPDES, SDS, construction short-form, and interim permits and the federal form only applies to NPDES permit applications. This will allow owners to complete only one form for any permit except the combined NPDES/SDS permit. Staff believes that this will be less confusing for the owners. For these reasons, the proposed subitem is reasonable.

Item B. Item B, as proposed contains, additional permit application content requirements for animal feedlots or manure storage areas that are capable of holding 1,000 or more animal units. These facilities are very large facilities that are often the most controversial and present unique issues due to the size of the facility. Therefore, it is reasonable to establish additional application requirements for these facilities.

Subitem 1. Under subitem 1, the agency proposes that applications from facilities having 1000 or more animal units contain an air emissions plan for the control and abatement of air emissions. This plan must include a description of methods and practices that will minimize air emissions from the animal feedlot and a description of measure to mitigate air emissions if an exceedance of the State ambient air quality standard for hydrogen sulfide is measured. As discussed in the Statement of Need, gaseous emissions from manure can affect human health at high concentrations including: nausea, headaches, eye irritation, throat and respiratory irritation vomiting, shallow breathing, modified olfactory function, coughing, sleep disturbances and loss of appetite. Air emissions from animal feedlots and manure storage areas is a serious matter that the agency has been attempting to address in recent years and continues to address through research and air quality monitoring. Research has primarily focused on control of hydrogen sulfide. However, according to the agency's Feedlot Air Quality Summary: Data Collection, Enforcement, and Program Development (MPCA Air Quality Feedlot Work Group, March 1999) (Exhibit G-3), "Researchers have indicated that the chemistry of feedlot odor may contain 168 separate chemical substances." This report made the following recommendations:

- Further research is needed in the following areas:
  - to identify which factors may affect the animal unit/hydrogen sulfide ambient air concentration relationship.
  - to determine if a relationship between hydrogen sulfide/odor emissions and animal species exists.
  - to identify which animal housing and ventilation styles affect hydrogen sulfide and odor emissions.
  - to determine if atmospheric emissions of ammonia need to be regulated in Minnesota.
- MPCA field staff need a more effective method of screening for ammonia emissions in the field.
- The MPCA, Counties, and producers need further research into the effectiveness, management and cost of mitigation methods for hydrogen sulfide and odors.

The Minnesota Office of the Legislative Auditor Animal Feedlot Regulation report, January 28, 1999. See Exhibit G-1. The Legislative Auditor's Report made comments similar to the above-cited recommendations. Indicating that more research is needed in the area of effective control of air emissions from animal feedlots and manure storage areas. Given that the methods to control air emissions from these facilities is still being researched, it is reasonable to not establish specific control and abatement measures in the proposed rule. Since odors and air emissions from these facilities are significant issues, it is reasonable to require owners address these issues proactively in their permit application.

Subitem 2. The agency proposes that an additional plan for preventing pollution by eliminating or reducing toxic pollutants, hazardous substances and hazardous wastes at feedlots. Pollution prevention is the least costly and most environmentally advantageous method for dealing with pollution. A well-followed pollution prevention plan will save money, reduce liability and prevent contamination of our precious natural resources. An “audit” of what chemicals or wastes are presently purchased or on location at the feedlot is the first course of action. Next, the owner should legally dispose of all hazardous wastes and purchase less toxic alternatives in the future. The Department of Agriculture has a toll free number (1-800-657-3986) which farmers can call to find out where and how to dispose of pesticides. Call the toll free number to also receive brochures on pesticide disposal. Antifreeze and used oil, according to state law, can either be returned to dealers who sold antifreeze or oil or the dealer must inform the customer who to contact for disposal. Household hazardous wastes (oven cleaners, nail polish remover, etc.) can be disposed of at scheduled county household hazardous waste collections. For these reasons, this subitem is reasonable.

Subitem 3 requires that an emergency response plan that will list procedures to contain or manage any unauthorized discharge be submitted with the permit application. The plan must also state that the proper authorities will be notified and identify specific steps that will be taken to mitigate any adverse effect of an unauthorized discharge. Animal feedlots and manure storage facilities may contain many types of pollutants and chemicals that are susceptible to spills such as herbicides, fertilizers, oils, grease, silage juices, etc. An emergency response plan will assure the public and agency that if a discharge occurs, the owner will be prepared and equipped to reduce any damage to the environment. For this reason, this subitem is reasonable.

Item C requires the owner to submit evidence that the owner has complied with the local government notification requirements of part 7020.2000, subp. 5. This notification requirement is needed to ensure local awareness of projects that may be objectionable to local residents. Further discussion of the details of this notification requirement is in the Statement of Reasonableness for part 7020.2000, subp. 5. Since many of the issues regarding the permitting of animal feedlots, manure storage areas and pastures are directly related to land use and the proximity of these facilities to local residents, it is reasonable to ensure that local governing bodies are aware of a project.

Item D requires the owner to submit evidence that the owner has complied with the local resident notification of proposed construction or expansion of any animal feedlot or manure storage area larger than 500 animal units as requirements of part 7020.2000, subp. 4. These two notification requirements are needed to ensure local awareness of projects that may be objectionable to local residents. Minn. Stat. § 116.07, subd. 7a, requires neighbor notification of proposed construction or expansion of facilities with 500 or more animal units. The proposed notification required under part 7020.2000, subp. 4 is intended to fulfill that statutory requirement. Further discussion of the details of these notifications is in this SONAR for part 7020.2000, subp. 4. Since many of the issues regarding the permitting of animal feedlots, manure storage areas and pastures are directly related to land use and the proximity of these facilities to local residents, it is reasonable to ensure that local residents are aware of a project.

Item E is a restatement of the requirement under part 7020.0500, item D of the existing rule.

Subpart 5. Establishes the permit processing requirements that the permitting authority must follow. Items A and B state that NPDES and SDS permits must be issued, reissued, revoked, or modified in accordance with Minn. R. ch. 7001 and this part. Minn. R. ch. 7001 establishes the permitting requirements for all permits to be issued by the agency unless specifically stated in other rule parts (e.g., Minn. R. ch. 7007 establishes all permitting requirements for air emission permits). The current rule is silent on the fact that these NPDES and SDS permits are issued in accordance with Minn. R. ch. 7001. This has resulted in some confusion among owners regarding the permit processing requirements. This item is intended to clarify that confusion. It is reasonable to clarify the permitting process.

Item C states that construction short-form and interim permits must be processed in accordance with this rule and cites parts 7020.0505 to 7020.0535 and part 7020.1600, subp. 4. Parts 7020.0505 to 7020.0535 establish the requirements for issuing construction short-form and interim permits as applicable to the commissioner and county feedlot pollution control officer. Part 7020.1600, subp. 4 establishes the permit processing requirements specifically applicable to delegated county permit processing. Construction short and interim permits are intended to streamline the permitting process. One of the methods of streamlining the process and reducing the amount of time to issue any permit is to increase the number of government units that can issue the permit. That is one reason for proposing to allow delegated counties to issue construction short-form permits. This item states how those permits are to be processed. To make the process of issuing construction short-form and interim permits as transparent as possible, it is needed and reasonable to state in this item the process for processing these permits.

Subpart 6. This subpart is a restatement and revision of part 7020.0900 of the current rule. The revision incorporates all of the proposed technical standards, parts 7020.2000 to 7020.2225.

7020.0535 Construction Short-Form and Interim Permits

This part of the proposed rule establishes the minimum requirements for construction short-form and interim permit applications and identifies the processing requirements for those applications. Construction short-form and interim permits are not subject to the public notice and comment process to which NPDES and SDS permits are subject. As stated in the Reasonableness as a Whole, these permits are intended to streamline the permitting process and reduce the amount of time needed to process a permit application. Construction short-form permits are intended to be issued to animal feedlots and manure storage areas that are proposing to construct or expand in accordance with the technical standards of the proposed rule. These standards, parts 7020.2000 to 7020.2225, establish the locating construction and operating requirements for all animal feedlots, manure storage areas and pastures. If an owner is proposing to do something that is not included in the technical standards (e.g., constructing a permanent manure storage site out of recycled tires), the proposed rules prohibit the owner from applying for a construction short-form permit.

The intent of the proposed rules is not to limit innovation in the matters addressed by the proposed technical standards. The intent is to use the permitting authorities' resources as efficiently as possible. For these reasons, the proposed rules require facilities that that apply for a construction short-form permit to comply with the technical standards. This limits the types of construction and operating methods that any eligible facility can employ but the methods in the technical standards incorporate the most commonly used construction and operating methods. Also for these reasons, owners that propose to construct or operate an facility in a method other than those set forth in the technical standards can do so by applying for and obtaining an SDS permit issued by the agency. Seethe SONAR for part 7020.0405 for further discussion on this topic.

Subpart 1. This subpart proposes the applicability for owners of animal feedlots and manure storage areas. This part applies to the owners that are applying for a construction short-form or interim permit.

Subpart 2. Permit applications submitted prior to the effective date of this part. This subpart establishes the process for permit applications submitted prior to the effective date of this part. The proposed rules state that the application can, if the facility is eligible for a construction short-form permit, be accepted as a construction short-form application if the owner so requests. The construction short-form permit application date will be the date on which the original application was made. In order to minimize duplication of effort on the part of the owner, it is reasonable to accept these applications as construction short-form permit applications.

Subpart 3. Delegated county procedures for denial and revocation. Item A establishes the procedures for denial of a construction short-form or interim permit. The procedures (as set forth in part 7001) are the same as those under the current rule for the denial of an interim permit. Given the similarity between the proposed construction short-form and the interim A permits that are issued under the current rule, it is reasonable to follow these same procedures for construction short-form permits. This item also states that the owner has the same rights of fundamental fairness as afforded other permits issued by the agency. This statement is made for the purpose of clarity.

Item B establishes the procedures for revocation of a construction short-form or interim permit. The procedures are the same as those under the current rule for the revocation of an interim permit with the exception of extending the amount of time that the commissioner has to review the revocation and make a decision. The proposed rules allow 60 days for commissioner review; the current rule allows 15 days. Given the agency backlog on permitting and other actions, 15 days does not allow enough time for the commissioner to review and act on a revocation action by a delegated county. Sixty days will provide enough time. It is reasonable to allow the agency enough time to make an informed decision regarding the revocation of a permit issued by a delegated county. Given the similarity between the proposed construction short–form and the interim-A permits that are issued under the current rule, it is reasonable to follow these same procedures for construction short-form. This item also states that the owner has the same rights of fundamental fairness and appeal as afforded other permits issued by the agency. This statement is made for the purpose of clarity.

Subpart 4. This subpart states that an owner that is required to obtain a NPDES or SDS permit and obtains a construction short-form or interim permit instead shall be subject to enforcement action for construction and/or operation without a permit. Construction short-form and interim permits are not subject to the same public notice and comment requirements as are NPDES and SDS permits. The public participation aspects of these permits (NPDES and SDS) are fundamental to the rights of interested parties to be informed and to provide input on a proposed project. The public participation requirements for a NPDES permit are a requirement of the federal regulations. For these reasons, it is reasonable to place the owners of these facilities on notice that they are subject to enforcement action for constructing or operating without a proper permit.

Subpart 5. Duration of construction short form and interim permits. This subpart establishes the duration of construction short-form and interim permits. Both permit shall have a duration of 24 months. Staff experience suggests that 24 months is sufficient time to complete the vast majority of construction projects and corrective and protective measures that will be permitted under the proposed permits. The current rules set forth a duration of 10 months for interim permits. Staff experience suggests that this is not sufficient time to complete large projects. Frequently the owner issued an interim permit for 10 months requests an extension to the permit. The permitting authority then reissues the permit for another 10 months. Occasionally, the permit is reissued for a third 10-month period. It is reasonable to increase the duration for interim permits and establish the duration of construction short-form permits for a length, which will accommodate the vast majority of the projects that will be permitted under these permits.

The proposed rules also limit the amount of time, which the permitting authority can extend a construction short-form or interim permit. Construction short-form permits may be extended for one 24-month period; interim permits for 90 days. Construction short-form permits will be issued to owners that are proposing to construct or expand an animal feedlot or manure storage area with more than 299 and less than 1,000 animal units (after expansion) in accordance with the proposed technical standards. Facilities that construct or expand in compliance with the technical standards will be fairly well defined; the risk of environmental problems from these facilities is significantly reduced from those that do not comply with the technical standards. Staff experience suggests that the number facilities that will need an extension beyond the 24-month period will be very small. However the risk of environmental harm in extending the period to 48 months is believed to be insignificant. For these reasons, it is reasonable to allow construction short-form permits to be extended for one 24-month period.

Under the proposed rules, interim permits will be issued to only those facilities that have been determined to be a pollution hazard. The definition of pollution hazard includes: 1) a facility that does not comply with the technical standards (parts 7020.2000 to 7020.2225) and was not issued a SDS or NPDES permit establishing an alternative construction or operating method; or 2) a facility that presents a potential or immediate source of pollution to waters of the state. By definition, the problems identified that cause a facility to be defined as a pollution hazard must be corrected. Some must be corrected in a very short time frame (e.g., a failed liquid manure storage area that is discharging significant quantities of manure directly to a water body) and others can be corrected over a slightly longer time frame (e.g., a poorly designed or constructed clean water diversion system that allows clean water to wash over an open lot during heavy rainfall periods). The intent of the proposed use of the interim permit is to provide a cooperative method by which the commissioner of county feedlot pollution control officer can get a pollution problem addressed quickly. If the pollution hazard cannot be corrected in a 24-month period and 90 day extension, the correction of that problem should be addressed at a higher level; either through an enforcement action or a permitting process that includes more public participation such as a SDS permit. The agency has a great interest in ensuring that identified pollution problems are corrected in a timely manner. For these reasons, it is reasonable to allow only one 90 extension to the proposed interim permits.

The proposed rules require the owner to notify the commissioner or county feedlot pollution control officer at least 90 days prior to the expiration of the construction short-form or interim permit. This will allow the permitting authority time to review the need for an extension and to determine what course of action is appropriate. This is especially important for interim permits since these permits will only be issued to correct a pollution hazard. The notification requires the owner to include permit and facility identification information, the reason for not completing the work, and the estimated timeline for completion. This is the minimum amount of information needed to make an informed decision regarding the permit authority's course of action. In addition to the information described, any feedlot that is subject to the neighbor notification required under part 7020.2000, subp. 4, those with 500 animal units after construction or expansion, must redo the required notification and provide evidence of having done so. The date that the original permit was issued and the proposed completion date must also be included in the notification. The proposed re-notification is intended to keep local residents informed. If, at the outset, the owner knows that the project will take longer than 24 months to complete, the owner should apply for a SDS permit for the proposed construction. Under the SDS permit, only one notice is required. It is reasonable to require projects that are known to take longer than 24 months to be permitted through the public notice and comment processes of the SDS permit. This additional notification should also provide incentive to the owners to complete the projects on time or to apply for an SDS permit which provides more opportunity for public participation. For these reasons, this proposed subpart is reasonable.

Subpart 6. This subpart sets forth the content requirements for construction short-form permits issued by the agency or delegated county. As stated in the Reasonableness as a Whole, one intent of the proposed technical requirements is to allow for more streamlined permitting for construction of animal feedlots and manure storage areas. This is accomplished through the inclusion into all permits the following statement: “The permittee shall comply with Minnesota Rules, parts 7020.2000 to 7020.2225 and all applicable requirements.” This statement would replace all of the technical requirements that would otherwise have to be stated individually in each permit. The ability to include all of these conditions in a single statement significantly reduces the amount of time needed to process any single permit. The agency anticipates that construction short-form permits could be as short as one or two pages containing the above statement and the information required in items A to H.

Items A to D include all the information needed to identify the owner(s) and the facility. This information is needed and reasonable to include in a construction short-form and interim permit.

Items E to G include the information that defines the essential limits of the facility, these being the number and types of animal feedlots, the maximum number of animal units allowed at the facility, and the number and types of manure storage areas. Plans and specifications will be incorporated by reference into each permit. These will be used to determine if the facility has been changed or expanded in compliance with the rules. Part 7020.0505, subp. 4, item A, subitem 6 require plans and specifications to be included in each permit application.

Item H requires the general permit conditions of part 7001.0150, excluding item P, to be incorporated by reference into each permit. These are general conditions included in each permit issued by the agency under Minn. R. ch. 7001.

Subpart 7. This subpart establishes the additional requirements for permit content for interim permits. Items A and B set forth the requirement that each interim permit contain a description of the corrective and protective measures needed to bring the animal feedlot, manure storage area or pasture into compliance with the technical requirements and a timeline implementing those measures. This statement of the corrective and protective measures is needed to enable an inspector to determine if the facility has complied with all needed measures to correct a pollution problem. For these reasons, it is reasonable to include this statement in each interim permit. Included in the technical requirements are the applicable discharge standards. Therefore, all facilities issued an interim permit will be required to come into compliance with the discharge standards with 24 months of the issuance date of the permit.

Item C is a restatement of the requirement in the current rule under part 7020.0500, subp. 4, item B, subitem 2.

Subpart 8. This proposed subpart establishes the requirement that no owner issued an interim permit that authorizes the expansion of an animal feedlot shall stock that expansion until the pollution problem that for which the interim permit was issued is corrected. The intent of this provision is to provide an incentive for owners to correct a pollution problem as soon as possible. Given the agency's great interest in correcting all pollution problems it is reasonable to require owners correct identified pollution hazards prior to stocking expansions. This issue is also discussed in this SONAR under part 7020.0405, subp. 2.

Delegated County Program

<u>7020.1600 Authorities and Requirements for Delegated Counties</u>

The agency proposes to change the existing title of 7020.1600 from "County Processing Procedure for Animal Feedlot Permit Applications" to "Authorities and Requirements for Delegated Counties." The purpose of the proposed change is to accurately reflect in the title the content of this part. The current title to part 7020.1600 implies that county programs are limited to processing permit applications. This does not accurately reflect the proposed content of this chapter. It is needed and reasonable to make changes that result in accurate and clear articulation of the rules.

This part provides the administrative procedures for the agency to delegate authority to counties for the purpose of implementing the feedlot permit application process. This arrangement with the counties is known as the "County Feedlot Program." The program has continued to expand since the 1978 rule allowing this state-local government arrangement was adopted. Today, 51 counties are delegated to administer the state feedlot program on behalf of the agency.

There are benefits resulting from administering programs at a local level. The feedlot owners may receive a more timely response on permit issuance, more accessibility and quicker answers to regulatory questions and a greater understanding by the regulator of the owner's concerns with local feedlot issues. A county program draws on natural strengths of local commitment by all constituents.

The agency supports the growth of the county role in feedlot regulation. The approach of having more permitting done at the local level has been successful. Several counties have permitted nearly all of their feedlots; other counties are doing more than 100 feedlot inspections annually. See Exhibit C-1.

The legislature has also supported the growth of the role of local governments in permitting feedlots. Beginning in 1995, the legislature appropriated funds to support the program. As of

1999, counties with delegated feedlot permitting programs may be eligible to receive up to $80 per feedlot annually for administering the program, an increase of $55 per feedlot since 1995.

To promote administration of the feedlot permit program at the local level, the agency needs to modify and expand the present rules governing the delegation of authority to administer the feedlot permit program. The needed changes include expanding the permitting authorities of the counties, increasing the emphasis on inspections, adding training requirements and increasing the level of accountability demonstrated by the county in implementing the feedlot permit program. The proposed rule changes can be broken down into the following set of responsibilities and authorities.

- Implement feedlot registration requirements;
- Process permit applications and issue construction short-form permits for new or expanding feedlots with 301 – 999 animal units;
- Process permit applications and issue interim permits for feedlots with 50 – 999 animal units that have been determined to be a potential pollution hazard;
- Develop and implement a comprehensive inspection program;
- Develop and implement a program for handling and tracking complaints; and
- Complete training requirements as required by the agency.

The following text discusses the principal reasons why the agency is justified in modifying the existing rules. This discussion identifies the main arguments why it is necessary and reasonable to expand county delegation authorities and, at the same time, include rules that increase the level of county accountability for satisfying the requirements of delegation.

By statute the agency is given the duty and responsibility to administer laws related to control of pollution and protection of the environment. The agency is also responsible for supervision of all programs relating to pollution and protection of the environment. Since the legislature has chosen to use the county as a means of administering feedlot regulatory responsibilities, the agency must have mechanisms in place to ensure that the counties are satisfactorily performing the necessary regulatory functions.

One of the agency strategies for the regulation of feedlots under the proposed rules is to emphasize more inspections and “field presence” than was the strategy 20 years ago. Because the agency relies on the county feedlot program to administer the feedlot rules, the agency is requiring the counties to have the same emphasis. Therefore, it is needed and reasonable that these requirements be explicitly identified in the rules.

Essentially, the revised rules do not impose new requirements upon the county. It clarifies inherent duties that are already there. Efforts to track and locate feedlots (i.e., registration), inspections, follow-up on complaints are duties and tasks that would occur in the normal course of administering an animal feedlot permit processing program. The agency recognizes that the existing language in statute and rules seems to limit the scope of duties for delegated county programs to permit processing-related duties. For example much of the language Minn. Stat. § 116.07, subp. 7, is framed in terms of “processing applications for permits.” The agency interpretation of this language is that, while it describes a particular model of the delegation program, it was not intended to limit the range of duties that could be designed into the program. Rather, the original delegation language took on this part because, when the delegation program was first initiated, it was for a feedlot regulatory program that relied most on permitting. The agency's view is that the dominating principle in establishing the delegated program is that counties be given a choice of whether or not they wanted to participate in administering feedlot regulations. Counties have the freedom to choose the program; it is not mandated. Within this context of choice, the terms and conditions of the agreement should be allowed to change provided they are in the best interest of establishing an effective program. As discussed in this SONAR under subpart 3 of this part, the revisions of the rules on delegation are being proposed because they are needed for an effective program.

The revisions provide more clarity and specificity to the rule. With increased clarity and specificity, counties will have more knowledge and a better understanding of their roles, therefore enhancing compliance with the rules.

The revisions take into account the changes and growth that has occurred to the county feedlot program since feedlot concerns became a major public issue in the early 1990s and since the onset of the feedlot grant program in 1995. Due to these two factors, the agency and the counties have worked together to increase the strength and capability of the county program. Counties have greatly expanded their regulatory efforts and the agency has taken steps to add more training, support and oversight to the county program. The growth and strengthening of the county feedlot program is evidenced by development of a guidance document on the role and responsibilities of a county feedlot officer in 1996. See Exhibit C-2. Then in 1998, a team of agency staff and county representatives met to develop an even more comprehensive document addressing all components of the delegation agreement between the county and the agency. See Exhibit C-3. This policy was a joint effort of the counties and the agency. By incorporating these and other policy developments into the revised rules, the agency is providing reliability and predictability for county feedlot programs to meet regulatory requirements.

The agency has designed the proposed changes to provide flexibility to the counties. Therefore, while the general level of obligations and requirements for the county is increasing, the proposed rules are devised to give the counties freedom to meet the requirements according to their individual circumstances. The flexibility begins from the start of a county's application for delegation. Counties, in a contract called a delegation agreement, create a program designed to fit the unique circumstances of their county. This agreement is then reviewed and negotiated with the agency on an annual basis. Through the partnership approach, flexibility is incorporated into the terms and conditions that make up the delegation agreement.

During rule-revision development, concerns were raised that these rule changes would result in increased costs for the delegated counties. The cost for a county to administer the county feedlot program has grown as the agency has continued to raise performance requirements for counties with delegated programs. However, financial support to the counties has also steadily increased. In 2000, most counties will receive more than twice the amount per feedlot as they did in 1995. See Exhibit C-4. Also, at least eight counties are presently meeting all core elements related to permit processing, including compliance follow-up and routine inspections. This is one indicator that the match between delegated county responsibilities and funding is adequate.

Subpart 1. The existing language of subpart 1 describes the steps that are required for a county to receive delegation. To improve the understanding of the rules on delegation, the agency proposes to rewrite the existing subpart so that it identifies all the major components of the delegation process. These parts are county board resolution, commissioner authorization, a signed delegation agreement, periodic delegation agreement review, and delegation withdrawal/revocation.

The resulting changes to the provisions of the existing subpart are discussed individually below. The title of subpart 1 has been changed from "duties of the county board" to "scope" to more accurately reflect the content of this subpart.

Item A of the existing rules requires that, as part of the delegation process, the county board must submit a resolution and, along with it, a statement describing the county's plan for processing permits. The agency proposes to move the part of the provision that requires submittal of a permit processing plan and to subpart 3, item B where all delegation application requirements are located. For order and clarity it is reasonable to group requirements of a common type together.

Item B. For clarity the agency has restated the existing language of this provision.

Item C. For order and clarity, the agency proposes a reordering of item C. The agency proposes to move the existing provisions of item C to subpart 2. The agency proposes to use item C to set forth the requirement that the delegation process must contain an agreement that is signed by the county board and the agency. The provision identifies this agreement as a "delegation agreement." The delegation agreement is a document that contains the county plans, procedures and goals for implementing the feedlot permit rule. Criteria for developing this document is provided in the proposed rule under subpart 3, item B.

This provision indicates one of the significant changes the agency is proposing to make to the county feedlot program. The proposed agency feedlot program that will be supported by this rule revision expands the administrative role of the county and, along with that, raises the counties' level of accountability. The delegation agreement requirement of this provision is one of the ways in which the agency proposes to incorporate greater accountability into the rules. As will be explained more fully in this SONAR for subpart 3, item B, the delegation agreement requirement means that, prior to receiving delegation, counties must present their plans, procedures and goals for accomplishing all the core duties related to administering the delegated permit program. This includes the county's plans for permitting and registration, inspections, education and assistance, and staff training.

Item D is a new provision proposed by the agency. It requires that the delegation agreement required in item C is reviewed periodically by the agency. Along with item C, this provision establishes the backbone of the agency's strategy to incorporate accountability into the delegated program. With the expanded role of the counties there must be an appropriate level of accountability. This provision requiring periodic review of the delegation agreement is a principal component to assist in achieving that goal. Therefore, for emphasis and clarity, it is appropriate that this provision be identified as one of the five main elements of the review process. The need and reasonableness regarding the periodic review requirement is provided in this SONAR to subpart 3.

Item E states that the rules on delegation contain a process by which the agency or a delegated county may terminate/withdraw from the delegation agreement. These provisions are cited in subpart 6 and subpart 7 in the existing rules and have been moved to subpart 5 and subpart 6 of the proposed rules. Because provisions for termination and withdrawal are an important consideration regarding the delegation process they have been identified in this subpart which acts as an overview of the rules on delegation.

Subpart 2. The agency proposes to reorder subpart 2 to add clarity to the general organization of the rules on delegation. The agency proposes to move the existing rule provisions on permit processing procedures from subparts 2 to 4. The agency proposes to use subpart 2 to state the requirements that must be fulfilled by a county feedlot officer of a delegated county.

Subpart 2 sets forth the specific duties and requirements that must be fulfilled by a county feedlot officer (CFO) of a delegated county. The existing rule establishes four specific duties of the CFO; the proposed rule identifies 11 specific duties. Some of the increase in this list is simply a matter of being more explicit about the duties listed in the existing rule. Other duties proposed as requirements for the CFO are totally new. These changes reflect the shift in strategy of the state feedlot program to place more responsibility and accountability at the county level. The recent Legislative Auditors Report criticized the agency for failing to conduct adequate oversight of the county feedlot programs. See Exhibit G-1. Under the proposed feedlot program counties will have more responsibilities and, therefore, accountability becomes even more important. It is reasonable for the agency to establish requirements under which the county's performance in administering the rules is at a level of effort that matches the state administration of the rules.

Item A requires the county feedlot officer to administer the feedlot program registration requirements as stated in part 7020.0350. Under part 7020.0350 all feedlots are required to register. The information obtained from registration is a fundamental need. It will be used to prioritize feedlots into basic categories of those most likely to be pollution problems. It will be used to create mailing lists needed for communication, education, technical assistance and outreach. It will be used to identify feedlot locations for inspection purposes. It will be used by policy makers to design on-going strategies. Therefore, the registration program is instrumental and needed to implement core feedlot regulatory tools.

The methods and practices used to conduct a registration program consist of tasks that are core to administering a feedlot program. This includes gathering information and conducting outreach as well as maintaining a database. These tasks are normal duties for a county feedlot officer (CFO) acting in an administrative capacity. Therefore, it is reasonable that the rule identify the duties for conducting feedlot program registration as part of the CFO's responsibilities.

Also, the registration program allows level II inventories to satisfy feedlot registration requirements. According to the records from the GEIS study, 44 counties are planning to have level II inventories completed by the year 2000. See Exhibit C-5. This fact indicates that county programs have already incorporated registration expectations as part of their program. Therefore, this provision is reasonable in that it is incorporating into the rule, regulatory policies that are already common practice.

Item B requires CFOs to conduct follow-up registration measures when feedlot owners have not registered within the required deadlines. The agency views this provision as a needed requirement to ensure effectiveness of the registration program. The value of registration is that it yields for regulators and policy makers a reliable and accurate of record of the number and location of feedlot operations in the state. Registration will not provide this product unless feedlots are registered.

The agency intends to use a variety of approaches to encourage feedlot owners to register. But, even with a well-implemented communications campaign, the agency recognizes that registration efforts will continue to be needed once the registration deadline has been past. In view of these circumstances it is needed and reasonable to incorporate into the rule a provision ensuring that CFOs will implement follow up registration measures once the registration deadline is passed.

Item C is a modification of subpart 1, item C(1), of the existing rule and it addresses CFO requirements for making permits applications available to feedlot owners. These modifications were made to make the provision consistent with the permitting requirements of the proposed rule. The essential meaning of the existing rule has not changed. The modification of this part includes a clarifying sentence that permit application forms used by the CFO must be in accordance with proposed chapter 7020 permit content rule requirements.

Item D is a modification of subpart 1, item C(3), of the existing rule and it addresses CFO requirements for reviewing and processing permit applications. These modifications were made to make the provision consistent with the permitting requirements of the proposed rule. For clarity, this part identifies interim and short-form construction permits as the permits that a CFO has the authority to issue.

The purpose of the provision is to provide instructions to the CFOs for issuing permits. Specific requirements apply to the issuance of interim and short-term permits. The CFOs must be aware of these requirements and comply with them in order that the permitting program is administered consistently and in accordance with agency design. The CFO is also expected to conduct permitting responsibilities according to the delegation agreement document that was prepared by the county and approved by the agency. It is reasonable for the agency to establish requirements that will result in satisfactory administration of agency rules.

Item E is a new provision proposed by the agency and it requires CFOs to conduct inspections as agreed upon by the county in the delegation agreement. The delegation agreement provision under subpart 3, item B, contains specific conditions that require the county to set goals and plans for various types of inspections. The CFO is required by this provision to use plans contained in the delegation agreement as a blueprint for conducting inspections. As a result, the inspection work done by a CFO should cover all categories and types of feedlots in a county. This includes large and small feedlots, feedlots that are new or expanding, and feedlots that have registered as well as those that have not.

The result of this provision is that it should work to resolve some of the perceived weakness in the existing program related to credibility. Comments from public comment letters as well as meeting during the rule revision process have criticized the program for issuing too much paper not verified by inspections, and for doing very little inspection work at feedlots that were unpermitted. This is evidence that a strong inspection component in the country program is needed.

Inspections are important to not only initiate corrective actions at facilities with pollution hazards. They are needed to support other regulatory tools used by the agency. For example, inspections are needed to verify that feedlot owners are complying with the permit requirements and registration requirements. Otherwise the importance of compliance by feedlot owners with these regulatory devices may diminish. Therefore, a strong inspection is necessary for all components of the feedlot program to operate effectively.

There are several reasons why it is reasonable for counties to administer the inspection part of the program. One of the primary reasons is that inspection work is logistically intensive. Driving to inspection sites can be time-consuming. It is not unusual for agency staff to drive one to two hours to reach a site. In most cases CFOs can reach these sites much more quickly. Therefore, from a time and resources standpoint, it makes sense for the counties to carry out the inspection duties. A second factor that bears on the reasonableness of this approach is that regulatory inspections, by nature, can generate uneasiness and fear by the regulated parties. If the counties do the inspections some of these factors that create anxiousness disappear. The county staffs have the built-in rapport of living in the community. Visits by them can help reduce, for the feedlot owner, the degree of unfamiliarity that may be present with agency staff visits.

The county feedlot grant program provides up to $80.00 per feedlot to counties to administer the feedlot program. At this level of support it is reasonable to require counties to perform inspections as part of their delegation responsibilities. Under the feedlot grant program, counties with significant livestock operations will receive more than $25,000. This should adequately fund, at least, a half-time county feedlot officer position. A half-time position should enable most counties to accomplish a reasonable inspection program.

Item F is a new provision proposed by the agency and it requires that CFOs review and process complaints. The need for this provision stems from the regulatory importance of complaints and from the agency strategy to greatly increase the role of counties in regulating feedlots.

Complaints are a key area of administering a feedlot permit program. The citizens of the state trust the agency to be able to intervene quickly when a feedlot problem develops. The ability of the agency to respond to complaints creates an important regulatory awareness for the feedlot owners as well as the general public. Also, the agency finds that feedlots with the most serious pollution problems are often identified as a result of complaints. These types of problems may not be identified as quickly through other regulatory avenues and therefore complaints provide the value of early identification and remediation. Therefore, the effective handling of complaints is important to the agency and, the agency must have a provision that makes clear the accountability for those performing complaint follow-up and processing. For this reason, this provision is a needed requirement in the rules on delegation.

Practical factors also bear on the value of requiring CFOs to review and process complaints. The CFO is typically located closer to the site of the complaint. They can respond to the complaint more quickly. Less regulatory resources are used. If several visits are required to resolve the complaint these logistical factors become even more significant.

Under the proposed feedlot program, CFO compliance duties such as complaint follow-up will increase from currently levels of responsibility. Expanding county permitting authorities for feedlots that need corrective action, requiring counties to have an inspection plan for all feedlots and requiring CFOs to conduct follow-up measures on all complaints have shifted CFOs duties to a role that clearly requires them to make compliance determinations. During rule development CFOs have expressed concern regarding the shift in their role from primarily assistance to one that combines assistance with compliance duties. The agency is working with the counties regarding these concerns. The main goal has been to distinguish between compliance and enforcement duties.

While the intention of the agency is to involve counties in the role of determining compliance and putting owners on schedules to correct pollution hazards, there is no intention by the agency to incorporate an enforcement component into the duties of the county programs. The agency's view is that, when CFOs encounter enforcement situations, they refer the matter to the state. Typically, this would include a situation where a CFO discovers a blatant violation (e.g., pumping, piping dumping manure to waters of the stare).

Enforcement is, also, a concern where there is a persistent failure by a feedlot owner to correct pollution hazards. This includes such situations as the persistent failure of a feedlot owner to install clean water diversions or buffer strips to prevent runoff from an open lot to nearby surface waters. Under these circumstances, the agency expects the CFO to document these deficiencies in an inspection report and to provide notification to the owner that the feedlot is in non-compliance and is subject to all agency rules and regulations including the authority to enforce compliance. In most cases, the CFOs compliance duties end at that point and, they should refer the matter to the agency or their county attorney for resolution.

The agency recently developed a policy document that clearly states that the agency continues to be ultimately responsible for enforcement. See Exhibit C-3. This is intended to be an assurance to CFOs that, when necessary, their delegation authority gives them the flexibility to refer feedlot compliance issues to the state for resolution.

Item G requires CFOs to provide assistance to owners of feedlots and manure storage areas in completing permit applications. This CFO requirement is contained in the existing rules under 7020.1600, subp. 1, item C.

Item H sets forth general recordkeeping requirements for CFOs. This provision is a modification of 7020.1600, subp. 1 (C) of the existing rules. The existing provision has been modified by adding the requirement that the records for complaints and inspections must be kept on forms provided by the commissioner. The agency proposes this change in order to improve the agency's feedlot database and consistency in the data collected and data storage. The agency is frequently asked by the public and interest groups seeking information on a certain issue for information about evidence related to a problem or the level of inspection activity that has been conducted. The Legislative Auditor report commented on the need for the feedlot program to track and maintain a record of complaints. See Exhibit G-1. The use of agency forms will help standardize the information and make it easier to log information into a database. Since this requirement will enhance the consistency of information as well as improve the efficiency of regulatory activity, it is a needed and reasonable revision to the existing rule.

Item I is a new CFO requirement proposed by the agency. It requires CFOs to submit an annual report to the agency. The content of the report is defined by criteria listed in the provision. These criteria require CFOs to submit data on permitting, inspection, complaint and education activities.

This requirement is needed by the agency to provide adequate oversight of the county feedlot program. To conduct a review the agency needs information on the performance of the county in administering the program. This provision ensures that the agency will receive the necessary information to do a satisfactory program evaluation. The Legislative Auditor has criticized the agency for inadequate oversight of the county feedlot programs. See Exhibit G-1. With the proposed expanded role of the counties in administering the feedlot program, the need for performance results related to county program increases.

For the agency to conduct a review it must have timely information on essential areas of the county program. The annual report provides this type of information. It shows performance results by the county in the fundamental components of the program. It provides these results annually.

Several factors bear on the reasonableness of this requirement. One factor is that delegated counties are familiar with an annual reporting requirement. Delegated counties have been required to submit annual report since the establishment of the feedlot grant program in 1995. See Exhibit C-6. For consistency and reliability, it is reasonable to codify existing practices into the rules.

A second factor demonstrating the reasonableness of this provision is that the criteria proposed for the annual report is consistent with the requirements of the delegation agreement as described under subpart 3, item B. These common criteria include permitting, inspections, complaints, education and training. Linking the terms of the delegation agreement and the annual report together should provide clarity and simplicity regarding an understanding of the feedlot program requirements for the CFO.

The CFOs must submit the annual report by April 1 of the year following the calendar-reporting year. This is a needed requirement in order for the agency to complete its oversight responsibilities in a timely manner. The deadline of April 1 is reasonable because it allows the CFO 3 months of time following the end of the reporting year to submit the report.

Item I, subitems 1 to 6. Item I, subitems 1 to 6 lists county feedlot program information that the CFO must submit to the agency on an annual basis. The data required pertains to county program registration, permitting, inspection, and education efforts. With the exception item I, subitems 1 and 6, this data is currently required in the existing CFO report. See Exhibit C-1. Item I, subitems 1 to 5 indicate county performance in the core components of the feedlot program and, therefore, is needed by the agency to conduct an adequate review. These requirements will not be a difficult task for counties to do as they will be compiling this information as normal part of their program operations. Therefore, these provisions are reasonable requirements.

Subitem 6. This subitem contains the agency's proposed requirement that the annual report to contain an analysis of performance results for the year along with recommendations for the subsequent year. This requirement is consistent with the purpose of the delegation agreement as well as the process proposed by the agency for negotiating changes to the agreement. It is needed and reasonable for the agency to set forth requirements needed to support successful implementation of the delegation agreement and to ensure adequate information is submitted to support MPCA’s oversight role

Item J requires county feedlot officers to participate in training necessary to perform CFO duties. This provision is needed to ensure that County Feedlot Officers (CFOs) will have the skills and knowledge to match the increased duties and responsibilities they will receive under the proposed revisions to this chapter. It is reasonable to establish training requirements to ensure that the county program is effective.

The agency presently has an active training program for CFOs. Training sessions are provided for CFOs in a number of venues throughout the year. This includes a 3-day annual training event as well as other special training events devoted to single topics such as concrete construction and nutrient management. Training is also a part of CFO quarterly regional meetings. The agency tracks training participation on annual reports and emphasizes training as a priority in policy documents to CFOs. CFOs have generally supported the need for on-going training and development to effectively do their work. Therefore, on the evidence of the value and support of existing training practices for CFOs, it is reasonable to make CFO training a requirement of the rules on delegation.

Subpart 3. For order and clarity the agency proposes to reorder the contents of subpart 3. The agency proposes to move the existing provision regarding permit issuance procedures to part 7020.0535, subp. 3; the agency then proposes to use subpart 3 to set forth the county's application requirements for delegation.

The proposed requirements for counties to become delegated are similar to the requirements of the existing rule. The main difference is that the agency is proposing a new part under item B that requires counties applying for delegation to submit a document that the agency has termed a "delegation agreement." In this document the county must describe the goals and measures they will use to implement the core components of the feedlot permit processing program. This provision requires them to discuss permitting, inspections, registration, complaint and response, education and outreach and staffing levels. The agency must approve the agreement. The need and reasonableness of this requirement is discussed under item B.

The lead paragraph of subpart 3 contains two significant provisions related to the delegation application process. One of the provisions requires that counties, delegated prior to adoption of the rule, prepare a delegation agreement document according to the criteria of this subpart and submit it to the agency by June 1, 2001. The second provision requires that delegation agreement documents be reviewed annually by the county and the agency. The SONAR for these provisions follows.

The first of these provisions serves the fundamental purpose of upgrading the delegation conditions of counties delegated prior to the rule adoption and to bring about needed improvements in feedlot programs in existing delegated counties. Although many existing counties have strong feedlot programs, some of them do not adequately administer the feedlot program. The 1999 Legislative Auditors report supports this assessment. See Exhibit G-1.

This provision requiring counties with existing delegation agreements to prepare a delegation agreement document is reasonable in that this requirement is consistent with the requirements for new counties who request delegation. This provision is also reasonable in that it provides the counties a reasonable time frame of one-year following rule adoption to prepare and submit a delegation agreement document to the agency.

The second provision in the lead paragraph of subpart 3 requires annual review of the delegation agreement document by the agency and the delegated county. This requirement is needed to ensure that the delegation agreement document is reviewed on a regular basis. The review satisfies an obligation of the agency to oversee the county program and maintain accountability. More importantly the review ensures that the delegation agreement document is assessed and evaluated for change. This creates an opportunity for the feedlot program to be as effective as possible. Factors such as past performance results of the county, changing feedlot demographics, changes in technology and changes in the strategy for administering feedlot regulations can be addressed during the periodic review and annual revisions.

An important part of the concept of the periodic review is the partnership nature of the review. Both parties of the delegation agreement will be working together to update and make appropriate changes to the agreement. It should be pointed out that, in instances where an amicable review of the agreement is not obtainable, subpart 5 and subpart 6 of this part allow either the agency or the county to terminate the delegation.

Item A requires a county to submit a resolution as part of their application for delegation. This is a requirement of the existing rule and is located in subpart 1, item A.

Item B states that counties applying for delegation authority must submit an agreement to the agency explaining their plans and goals for administering the feedlot program. The provision contains a list of specific criteria that the county must address in the agreement. The provision includes the condition that the commissioner must approve the agreement.

The backbone of the agency's strategy to conduct oversight of the county program is through use of the delegation agreement set forth in the requirements of this provision. With the expanded regulatory role proposed for the counties, the agency needs more accountability mechanisms than are provided in the existing rule to ensure that components of the program are administered effectively. The delegation agreement document satisfies a major part of this need.

The delegation agreement provision is a reasonable approach for the agency to use to address the matter of accountability. The agency recognizes that in order for county delegation to be an attractive program to counties it must be responsive to the needs and preferences of the individual counties. This approach does that by giving the counties the flexibility to design the program that they see as most appropriate for their county. At the same time, it gives the agency assurance that the county will follow through with core aspects of the feedlot permit application process.

The agency views the nature of the work needed to complete the delegation agreement document as negotiation. Counties may put forth a plan for implementing the rules and the agency has an opportunity to respond with any concerns it might have. Differences and concerns can be resolved through discussions and meeting and the delegation agreement can be subsequently signed by the agency and county. Because the delegation agreement fits this approach of giving counties flexibility and commitment, it is reasonable for the agency to use it as an approach to maintain and facilitate a working agreement between the county and the agency.

Subitem 1 contains the agency's proposed requirement that counties to submit in their delegation agreement document an inspection plan that addresses three categories of feedlots. Under these categories counties must have a general inspection plan that subjects all feedlots with less than 1,000 animal units to an inspection. Counties also must have specific plans for inspecting construction projects at new and expanding facilities and for inspecting feedlots that are operating under the interim corrective measure conditions as defined in part 7020.2003, subp. 5. The need for the agency to require counties to use inspections as part of a program to regulate feedlots is discussed in subpart 2, item E.

Unit (a). The agency proposes that counties have an inspection strategy that will result in the identification of feedlots with pollution hazards. Correction of pollution problems at existing feedlots is a primary goal of the agency feedlot program. The intent of this provision is that counties will develop an inspection plan that will result in inspections being conducted at feedlots most likely to contain pollution hazards. Under this category the agency will expect to see counties develop a method for prioritizing feedlots according to their potential to be a pollution hazards. Some of the most likely criteria would be feedlots in shoreland, feedlots under 300 animal units and feedlots that have never applied for a permit application. Preparation of a plan to address these feedlots should support the implementation of these inspections. It should also ensure that these inspections are carried out systematically. A systematic approach is important in that it creates a regulatory atmosphere whereby feedlots in high-risk categories will recognize that they are subject to inspections. It is reasonable for the agency to establish requirements that will enhance the uniform and consistent implementation of the rules.

Unit (b). In this subitem, the agency proposes that counties submit in the delegation agreement document a plan for inspecting feedlot construction projects. This requirement is consistent with a principal agency strategy to protect the environment by insuring that new construction is built according to feedlot construction technical standards. Historically, this is the most common type of inspection that delegated counties have performed. While the agency will not require every construction site to be viewed, the intent of this requirement is that inspections should be done at a frequency to demonstrate that agency design standards are being followed and that proper construction practices are being observed.

Unit (c). The agency proposes that counties set goals for inspecting feedlots that are operating under the interim corrective measures option as described in part 7020.2003, subp. 3 to 6. Under this option feedlot owners are given until 2009 to fully comply with state water quality standards provided they agree to implement a set of low-cost corrective measures before October 1, 2003. This agreement will be executed by a signature of the feedlot owner on an agreement form provided by the agency. Because of the minimal documentation required, an inspection is the only way for the agency to guarantee the integrity and credibility of the agreement. The on-site inspection will indicate whether the feedlot owner has installed corrective measures according to part 7020.2003, subp. 5. It is needed and reasonable for the agency to establish procedures to verify that regulated parties are in compliance with their regulatory agreement.

Subitem 2. Under subitem 2, the agency addresses feedlot requirements at feedlots with more than 300 animal units. Inspection categories are the same as they are for feedlots with less than 300 animal units under item B, subitem 1, except that unit c does not apply to feedlots with more than 300 animal units. The need and reasonable rationale for this provision are the same as item B, subitem 1, units a and b.

Subitem 3. Subitem 3 contains the requirements for the counties to state goals that they plan to use for implementing the permitting system. Under the proposed rules counties will be responsible for most permitting duties under 1,000 animal units. This is an important responsibility as it is the chief regulatory tool that will be used to regulate construction at new and expanding feedlots and to correct pollution problems at existing feedlots. To accomplish its oversight duties, it is needed and reasonable for the agency to require counties to develop and submit plans for an area that is a core component of the feedlot program.

Subitem 4. The agency proposes that counties have plans and goals for administering the proposed registration requirements. The agency is relying on feedlot registration as a primary tool to track and maintain regulatory oversight of feedlots with less than 300 animal units. It ranks with inspection and permit processing as the main parts of the feedlot program. It is reasonable for the agency to require counties to develop and submit plans for an area that is a core component of the feedlot program.

Subitem 5. In subitem 5, the agency proposes that counties state the procedures and goals they intend to use for addressing the complaint component of feedlot regulation. Complaints are a fundamental area that must be handled effectively for the successful implementation of feedlot regulations. The counties are in an ideal position to respond quickly to complaints as well as to understand the circumstances that will be required for resolution. Additional SONAR discussion and justification for this provision is provided under subpart 2, item F.

Subitem 6. Subitem 6 contains the proposed requirements that counties provide in their delegation agreement document a strategy for providing assistance to feedlot owners. It is a modification of subpart 1, item C, unit (4) of the existing rules. The proposed provision requires that CFOs provide compliance assistance. Compliance assistance means that CFOs will be a resource for owners to solve their feedlot problems. This assistance will be chiefly in the form of assisting owners to locate resources and to develop a corrective action plan. CFOs may provide information regarding low-cost measures such as the use of clean water diversions, buffer strips and regular lot scraping. This assistance role is especially important for those feedlot owners under 300 animal units who choose and are eligible for the interim corrective measures plan. Compliance assistance does not mean that CFOs provide actual design and review services for construction that is governed by the technical standards. It should be noted that CFOs have expressed concern that assistance, especially compliance assistance, might mean that they have to do enforcement as part of the program. As explained under subpart 2, item F, this is not a correct interpretation of this requirement.

Subitem 7. The agency proposes that counties must indicate in their delegation agreement document the number of staff they intend to use to administer the feedlot program. This is a new requirement and the agency is proposing it as a way to evaluate whether or not the county has adequate staffing to execute the plans.

The agency is proposing this requirement as a result of past experience with the county programs. Records from annual reports since 1995 indicate that the level of staffing from county to county varies significantly. See Exhibit C-7. The reports show that several counties have more than 1 FTE conducting feedlot duties while others as invested as little as one-tenth of an FTE. While feedlot program accomplishments are not always directly related to staffing levels, extremely low level of staffing would raise reasonable concerns regarding the ability of a county to adequately administer the program.

This requirement does not mean the counties must meet a standard or quota. The agreement is intended to give counties the ability to design a program according to their needs and the concept of the delegation agreement document is that is negotiable. Therefore, the staffing level requirement is reasonable because it allows both parties to make adjustments for achieving the intended goal.

Item C requires agency authorization before the county delegation becomes effective. This is a requirement of the existing rule and is located in 7020.1600, subp. 1, item B.

Item D requires the county to designate a county feedlot officer as part of the requirement for obtaining delegation. This is a requirement of the existing rule and is located in subpart 1, item C. The specific duties of the CFO are contained in subpart 2.

Subpart 4. Subpart 4 contains the procedure requirements that must be observed by delegated counties when processing feedlot permit applications. Permit procedure requirements are located under 7020.1600, subp. 2, of the existing rules. The agency proposes to modify the existing procedural requirements to be consistent with the proposed changes in the permitting system and to incorporate changes resulting from the broadening of permit issuance authorities for delegated counties.

The SONAR discussion for the proposed changes to the permitting system is provided under part 7020.0405. The SONAR discussion for expanding the permit issuance authority of the counties is provided under item A.

Item A establishes the county's authority to issue construction short-form and interim permits. The rules governing construction and short-form permits are set forth in 7020.0535. As a result of this provision counties are allowed to process and issue permits for most feedlots under 1,000 animal units.

The need for the agency to shift more permitting responsibility to the counties can be explained in terms of the benefits associated with having regulators located close to the sites they are regulating. These benefits include a greater capacity to respond, a greater understanding of local issues and greater local commitment to regulations than is provided by direct administration from the agency. Other factors demonstrating need and reasonableness for expanding county permitting authority are listed below:

- Existing strong county programs demonstrate that local regulation is an effective approach.
- Counties are eligible to receive significant financial support to administer the program.
- On-going training provides county feedlot officers with the necessary technical and administrative skills.
- Counties have generally welcomed the opportunity to do more permitting.

- Counties are given the option to forward difficult and complex permit applications to the agency.

Item B is a restatement of subpart 2, item C of the existing rule. It contains a set of criteria under which counties must forward permit application to the agency for processing. The agency proposes to amend the criteria. The SONAR for these changes is discussed in item B, subitems 1 to 6.

Subitem 1. Subitem 1 is a modification of a permit processing procedure under part 7020.1600, subp. 2, item C of the existing rules. The agency proposes under this subitem that feedlot applications from facilities that are subject to permitting requirements under part 7020.0405 must be forwarded to the agency for application. The feedlots subject to these permitting requirements are feedlots that require NPDES or SDS permits.

The need and reasonableness associated with the NPDES permit application requirement is that delegated counties do not have authority to issue NPDES permits. Regarding the SDS permit application requirement, the agency view is that counties, generally, do not have the technical capacity needed for an adequate review. SDS permits are used for facilities where permit application reviews are complex. This includes feedlots with more than 1,000 animal units that may be subject to a SDS permit. It includes feedlots with less than 1,000 animal units that, for technical or administrative reasons do not meet interim and short-term construction permit requirements. It is needed and reasonable for the agency to establish procedures that promote a competent and credible permit program.

Subitem 2. This subitem restates the requirements subpart 2, item C, subitem 4 of the existing rule. It requires counties to forward applications to the agency for feedlot or manure storage areas in those cases where manure is not used as a domestic fertilizer.

Subitem 3. The agency proposes that counties forward to the agency permit applications for owners of feedlots with 500 or more animal units that are proposing to construct liquid-manure storage near specific topographical features characteristic of limestone geology. These features, including sinkholes, caves and disappearing streams, may contain direct conduits to ground water and are a serious pollution threat. In order to ensure that proposed construction near these features is safe and reliable, a high level of technical expertise to review the project is needed. Most counties do not have these resources available; the agency is staffed with professional engineers than can provide the necessary expertise. Therefore, it is reasonable to establish a provision that requires counties to forward these applications to the agency for review.

The provision is, also, reasonable because considers the level of the potential pollution threat created by feedlot size and the distance of a facility to a geographically sensitive feature. If either the facility size increases or the proximity of a structure to one of the sensitive geologic features decreases, the magnitude of the pollution threat will increase. The size threshold of 500 animals units and the distance threshold of 1,000 feet are parameters used to establish rule provisions for similar applications in feedlot-related rules and regulations. It is reasonable for the agency to establish provisions that promote uniformity.

Subitem 4. Subitem 4 contains the agency's proposed requirements that counties to forward permit application to the agency from owners proposing to construct new feedlots or modify existing feedlots in a vulnerable drinking water supply management area. The need and reasonableness for proposing this version is similar to subitem 3. Drinking water supply management areas inherently pose a higher pollution risk and proposed feedlot construction in them warrants more scrutiny than feedlots operating in more typical settings. Agency staff has the expertise available to evaluate additional geographical factors and structural designs connected with these projects. Therefore, it is reasonable that the counties forward applications to the agency for review. The provision contains a condition that limits the application of the provision to feedlots with 500 or more animal units. The reasonableness of this condition is explained in paragraph two of subitem 3.

Subitem 5. This subitem contains the agency's requirements that counties forward permit applications to the agency from owners of feedlots in sensitive geographical areas that have less than 300 animal units and who are proposing to construct liquid manure storage to correct a pollution hazard. In order to ensure that proposed construction in sensitive areas is safe and reliable, a high level of technical expertise to review the project is generally needed. Most counties do not have these resources available. On the other hand, the agency is staffed with professional engineers than can provide the necessary expertise. Therefore, it is reasonable that the counties forward applications to the agency for review.

Subitem 6. The agency has proposed in this subitem that the counties to forward those applications where the feedlot owner is applying for a variance to accomplished proposed changes. Counties do not have the authority to grant variances of MPCA rules under the delegation. Therefore, it is needed and reasonable that the counties forward these applications to the agency for review.

Item C is a restatement of the existing rule. It provides counties the option to forward any permit application to the agency for either technical assistance or permit issuance. For clarity and completeness the agency has amplified the existing language. Under the revised provision, the county must submit a request along with the application stating the desired action sought by the county. The agency in return agrees to complete permit issuance as requested and to keep the county informed during the processing of the application. The result of adding these conditions is that it improves communication between the county and the agency. It is reasonable for the agency to incorporate processes that clarify and improve the effectiveness in administering of rules.

Subpart 5. The agency proposes to delete subpart 5 of the existing rule. The SONAR for this is discussed below. The agency proposes to use subpart 5 to establish the provision stating the procedure for counties who wish to discontinue their delegation agreement. For clarity and completeness the agency has added language to explicitly state that a request for withdrawal must be sent to the commissioner. Subpart 5 of the existing rule establishes a time frame of 15 days in which the commissioner is allowed to review permit applications forwarded by the county. Agency experience in processing permit applications indicates that 15 days is not a realistic amount of time for staff to conduct an adequate review. The inflow of applications to the agency varies significantly according to the time of the year. During some periods of the year, such as early spring, the volume of permit applications makes it impossible to meet a 15-day schedule. Application complexity is also a factor that slows down the permit review process. Most of the permit applications received by the agency from the county are for the most problematic feedlots. These are feedlots where the significance of the pollution hazards, the history of noncompliance, or technical difficulties are such that careful review is warranted. The agency considered increasing the duration time limit from 15 days to 60 days, but concluded that the complex and unpredictable nature of these permit applications is such that no time limit can reasonably be established. Therefore, the agency proposes deletion of this provision. It is a needed and reasonable to delete a provision when it is shown to be inconsistent with facts upon which it was established.

Subpart 6 is that same as part 7020.1600, subp. 7, of the existing rule. For clarity and completeness the agency proposes to add language that explicitly identifies Minn. R. ch. 7020 as the basis for which to establish revocation of county authority. Similarly, the agency proposes to replace “application review” with “delegation” to make it explicit that revocation applies to all terms and conditions of the delegation agreement.

Standards for Discharge, Design, Construction, Operation and Closure

The proposed rule consists of four main subject areas: registration, permitting, county feedlot programs and standards for discharge, design, construction, operation and closure (technical standards). Among the many possible ways to regulate animal feedlots and manure storage areas, the agency has in the past chosen to regulate them through issuing site specific permits and certificates of compliance as discussed in this SONAR under parts 7020.0400 and 7020.0405. The permitting requirements of the proposed rules are a relatively small, but very significant, part of the shift in the strategy for regulating animal feedlots, manure storage areas and pastures. In addition to the proposed rules revisions, the agency has undertaken the task of redesigning the feedlot program at the agency in an attempt to optimize (from an environmental outcome standpoint) the use of staff resources. The general direction of the redesign has been to emphasize work to be done “in the field” and to de-emphasize paper reviews to determine if an environmental goal will be achieved. As discussed in this SONAR under parts 7020.0400 and 7020.0405, the impetus for the redesign of the program was to make the best use of the agency and delegated county staff to achieve the best possible environmental outcome. The proposed rules, as a whole, are intended to allow the agency and delegated counties to shift staff resources from primarily doing paper reviews to doing a significantly increased number of inspections, education and outreach activities. The proposed rule is intended to allow and encourage the agency and delegated counties to focus efforts and resources for regulating facilities from reviewing paper work to greater field presence and one-on-one contact with facility owners.

The four main portions of the proposed rule, registration, permitting, county feedlot programs and technical standards are all designed and intended to work together to achieve the best possible environmental outcome while considering the resources available to the agency and delegated counties. The proposed technical standards in parts 7020.2000 to 7020.2225 establish the minimum location, construction, and operational requirements needed to minimize the environmental impact of these operations. One of the reasons for including the technical standards in the proposed rule is to reduce the need to use permitting as the regulatory tool for a large number of animal feedlots, manure storage areas and pastures. The proposed rules include clearly stated technical standards that are broadly applicable. By including clear technical standards and making them broadly applicable, the need for issuing individual site-specific permits that impose location, construction and operating conditions on any facility, is greatly reduced. These technical standards also reduce the amount of time needed to draft and issue permits for facilities required to obtain a permit. This time savings is realized through establishing the general requirements applicable to all facilities, compared to the current feedlot regulatory program which does not address general requirements other than the discharge standards.

The proposed permitting system is also intended to take advantage of the technical standards by reducing the number of permits the agency or county must issue. The proposed rules generally allow owners with fewer than 300 animal units to construct and operate within the constraints of the technical standards without applying for or obtaining a permit. Owners with more than 300 animal units that propose to locate, construct and operate in accordance with the proposed technical standards will be able to do so under a streamlined permitting system called "construction short-form" permits. Owners with fewer than 1,000 animal units will not be required to apply for an operating permit, provided the facility is constructed and operated in accordance with the technical standards and the facility is not a CAFO that is required to obtain a NPDES permit.

Finally, the proposed regulatory system is a somewhat new approach to regulating these facilities. In many ways, the proposed system is about owners accepting responsibility for the environmental performance of their facility and the agency accepting that these owners will do what is needed, and what is required in the technical standards, if they know up front and understand what is needed and why it is needed.

7020.2000 Overview

The Overview section is a general adaptation and reconfiguration of 7020.0400, General Requirements, of the existing rule. It is comprised of six subparts. Subpart 1 contains some of the most core requirements for which all facility owners and persons involved in handling manure must comply. The remaining subparts are provisions that address subjects that do not fit into the major technical sections comprising the proposed rules.

Subpart 1. In General. Subpart 1 contains the fundamental provision making up the feedlot rule with respect to the technical standards in parts 7020.2000 to 7020.2225. The statement that all owners of animal feedlots, manure storage areas and pastures, and any person handling manure are subject to the applicable requirements. For clarity, this statement is needed to inform all persons that, if their operation produces, stores, disposes, transports or utilizes animal manure or process waste waters, they are subject to these rules in general and more specifically to one or more of the technical standards sections. This provision is reasonable because it demonstrates an important distinction regarding regulation of manure-related operations by making it very clear that all persons, whether or not they are required to apply for a permit, are subject to all technical requirements of these rules.

Subpart 2. Animal manure and wastewaters not used as domestic fertilizer. This provision informs owners who use and/or dispose of manure by means other than application to land, that they must do so in a manner that does not result in pollution. The reference to applicable rules is needed and is intentionally broad because there will continue to be new methods of processing and handling manure that are not addressed in these technical standards. This is reasonable because the agency fully intends, upon inquiry from an owner, to assist the owner in determining what applicable rules apply to their proposed alternative methods. This subpart also requires owners not using manure as domestic fertilizer to apply for an NPDES or SDS permit. This is reasonable because it allows the agency to review the proposed operational methods prior to implementation by the owner and allows for public noticing and comment of new or unique operational methods that may affect them. The agency may also assist the owner, if necessary, in determining if any additional regulations govern the proposed operation.

Subpart 3. Manure packs and mounding. This is a new provision proposed for the feedlot rule. It requires feedlot owners and operators, who use “manure packs” or “mounding” as a component of their manure handling system, to remove the manure from the feedlot on an annual basis. Mounding is a practice where manure to pushed together to create a raised area in open yards that cattle can stand on to keep dry during times of the year when the feedlot is wet and soft. “Manure pack” refers to a form of manure handling where the manure is allowed to accumulate in the area the animals are confined and where the hoof traffic of the animals presses the manure into a dense mat. These practices are typically used at feedlots with less than 1,000 animal units. One might expect that these forms of manure handling would be classified as stockpiles and, therefore, be subject to the proposed stockpiling rules. There are, at least, two reasons for not doing this. One, is that mounding is addressed by the rule requirements that control runoff from open lots. It does not make sense to establish standards for both open lot runoff and manure pack/mounding runoff when the open lot runoff is already addressed by the rule.

A second reason for treating manure packs/mounding different than stockpiles is that cattle traffic within confinement areas is constantly packing and compressing loose material, including manure, into a packed-layer. This layer acts to create a seal between the manure liquids and a high water table or seasonally saturated soils that may be located below the surface of the lot. This reduces the risk of ground water contamination that can occur from leaching. The agency has limited the time that these manure accumulations can be maintained at one site to one year before they must be removed. This is required as a precaution to prevent damage if use of the confinement area is interrupted and manure seal deteriorates. An example of this situation occurring is where cattle are confined to a yard in the winter but are pastured during the growing season. Also, while the sealing phenomena created by hoof traffic is recognized, there is evidence indicating that some leaching of manure materials in to the soils under feedlots continues to persist. A study has shown that an increase in nutrient buildup occurs in the soils at operations that use these practices. With limited research available and with the dependence by some feedlots owners on these practices, the agency believes the one-year removal requirement is an acceptable compromise.

Subpart 4. Newspaper notification of proposed construction or expansion. This provision is needed to allow adequate notification of local neighbors of proposed constructing or expanding animal feedlots or manure storage areas and to eliminate common misinterpretation of statutory requirements under Minnesota statute section 116.07, subdivision 7a. Incorporating this into the proposed rule is reasonable because it will help provide consistency in how these notifications are completed and the owner clearly knows what specific information to publish. This provision identifies the specific information needed in the notification, which if completed, will meet the requirements of the statute.

Under the current statutory notification requirements, the owner of a facility having 500 animal unit or more, must only include the livestock type and proposed capacity, and the notice can be completed in person, first class mail or by publication in local a newspaper, not more than 10 business days after submitting a permit application. The agency has had several instances where persons interested in a project have challenged the legal accuracy of a notice. For example, one notice stated that the owner was building a swine operation with more than 500 animal units, when the owner was proposing a swine operation that consisted of over 800 animal units. A second example is where on several occasions, a letter was sent to the owners neighbors, but the neighbors maintained that they had not received the notification until the project was already approved by the permitting authority. This provision is also reasonable because it will prevent these types of misunderstandings, and will require that the notice has been completed prior to obtaining a SDS or NPDES permit from the agency or a construction short form or interim permit from the agency or delegated county. For more discussion on the need and reasonableness of these notifications, see parts 7020.0505, subpart 4, “contents of permit applications” and 7020.0535, subpart 2, discussion of when a permit application is “complete” and can be processed by the agency or delegated county.

Subpart 5. Government notifications of proposed construction or expansion. Item A of this subpart is needed to fill the gap of a permit application not being required for facilities constructing or expanding to a capacity fewer than 300 animal units. The provision requires notification to the delegated county, or the agency in non-delegated counties, of a proposed project at least 30 days prior to commencing construction. The notification must be on a form provided by the commissioner and contain the information listed in subpart 4 items A to F and the anticipated date of starting construction. This is reasonable because owners with fewer than 300 animal units who are constructing or expanding do not need to apply for or obtain a permit prior to commencing construction, and there would be no mechanism in place to allow the agency or delegated county the ability to plan for inspections or conduct a summary review of the location or manure storage plans. The second part of this provision states that the owner who has submitted liquid manure storage area plans to the agency or delegated county, has met this requirement. This is reasonable because it eliminates duplication of notifications by the owner.

The discussion of the permitting sections of this SONAR (parts 7020.0405 to 7020.0535), discuss in detail the permitting structure proposed in this rule. Several county feedlot officers and members of FMMAC have proposed an alternative approach to include the requirement that all facilities constructing or expanding between 50 and 300 animal units be required to apply for a construction short form permit. This provision should be deleted if the permit system changes to require the construction short form permits for owners having 50 to 300 animal units.

Item B of this subpart is needed to inform local governmental units, especially in non-delegated counties, of proposed projects and for facility owners to become aware of any other requirements or restrictions outside of the state and federal regulations. This is reasonable because it provides a mechanism for communication between the owner of a proposed facility and all levels of government that potentially have requirement is addition to state and federal regulations.

Subpart 6. Record of livestock owners and manure sources. This provision requires owners of animal feedlot and manure storage areas to maintain records of the names of persons who own livestock which are raised at the feedlot or whose facility produced the manure which is stored in a manure storage area (if not produced at the feedlot). This issued was discussed briefly at the October 11, 1999, FMMAC committee meeting. The primary commenter suggested that MPCA require the names of all livestock owners to be identified in a permit application and/or registration form. The FMMAC group as a whole thought that having this information up front was not possible for many facilities because of the nature of the operations. For example, a cattle feeder may have several cattle from many different owners being feed at their facility and the names and numbers often change from year to year. Therefore, it would be unreasonable to require the owner to reapply for a permit or reregister based on just a change in ownership of a portion of the livestock raised at the facility. As an alternative, the group discussed that it was reasonable to require the owner to record this information, maintain it on file for at least three years and make it available upon request by the commissioner or county feedlot officer.

This information is needed by the commissioner or county feedlot officer if and when a pollution problem arises that requires consideration of formal enforcement actions. This provision is further reasonable because it allows the agency the needed information to seek penalties and corrective actions from all potentially responsible parties and also provides an incentive to owners of livestock to be involved in and assist the facility where their livestock are raised in maintaining compliance with the rules.

<u>7020.2002 Hydrogen Sulfide Ambient Air Quality Standard Applicability</u>

This provision is intended to address the Governor Ventura's direction that the agency address the purpose of the vetoed Chapter 204, House File 1235, a bill relating to the regulatory requirements for feedlots. The Governor addressed this issue in a letter to speaker of the house, The Honorable Steven Sviggum, dated May 25, 1999 (Exhibit G-4). This provision compromises at the midpoint of the recommended 14-21 day period that farmers should be allowed, as described in the Governor's veto letter. This issue was also one of the nine priority issue discussed during the six FMMAC meetings held from May-October 1999 (Exhibit O-4). During the October 11, 1999, meeting FMMAC also discussed the reasonableness of including a five-year sunset date for the provision.

The exemption from the hydrogen sulfide standard only applies during agitation and pump-out of a liquid manure storage area and if the owner complies with the requirements in items A to C. Exempting only liquid storage areas is reasonable because the agency's experience has been that they are by far the most likely to have emissions that could exceed the standard. In addition, providing an exemption only during pump-out and agitation is reasonable because this is the most likely time of operation that an exceedance would occur. The exemption, in general, is reasonable because it allows owners of liquid storage areas to operate in compliance with the law, while implementing best management practices to minimize emissions. At this date, the base of knowledge on how to control hydrogen sulfide emissions from liquid manure systems (during agitation and pump-out) suggests that costly remedial measures or equipment are often needed. It is reasonable to allow the livestock industry some time to address hydrogen sulfide emissions in a cost effective manner. For this reason, the agency proposes that this provision expire on July 1, 2005. The five year sunset date was originally proposed in legislation for an air quality easement that an owner could obtain from their neighbors, however, the agency believes that the five year period is needed and reasonable here because it will allow the agency, Minnesota Department of Agriculture, University of Minnesota Extension Service, FMMAC, and producer groups to better address air emissions of hydrogen sulfide resulting from the agitation/pump-out event.

This provision also states that the agency retains it's emergency powers authority under Minnesota Statutes, section 116.11. This is needed so that owners who obtain exemption under this part realize that they may be required to address hydrogen sulfide emissions from their facility, if human health is threatened by their operation. It is reasonable to restate the agency's authority here because owners may view this as an exemption from being required to implement additional remedial measures or equipment. However, this is not the case. Owners eligible under this part are exempt only from the hydrogen sulfide ambient air quality standard itself.

As mentioned above, the allotment of 17 days annually was selected as an approximate midpoint between the two bills that attempted to address the issue in statute, one selecting 14 days and the other 21 days. The agency proposes 17 days annually because it allows owners of most facilities throughout the state adequate time to complete pump-out and agitation of the storage areas. Some of the moderate to larger sized facilities will conduct agitation and pump-out for more than 17 days annually, however, they may not need an exemption on each of these additional days. The agency believes it is reasonable for the owner to select the days which are most likely to create a potential exceedance of the standard. In this way, owners will better understand the factors involved (e.g., wind direction and speed, temperature, distance to property line) and are better able to minimize potential emissions from the sources at their facility.

Item A requires the owner to notify the commissioner or county feedlot officer of the anticipated number of days and the start date of agitation and pump-out. This is reasonable to allow the agency or county to schedule an inspection and air sampling monitoring to better assess the potential for emissions at the facility. It is also reasonable because the agency can then respond to any complaints directed at the facility and inform the complainant the best management practices (BMPs) the owner of the facility is following in item C.

Item B requires the owner to inject or incorporate the manure into the soil within 24 hours of land application. This is reasonable because it is a BMP for minimizing hydrogen sulfide and other air emissions during land application of manure and implementation of this BMP will likely help offset some of the emissions created by the agitation and pump-out event.

Item C requires the owner to implement BMPs for the control of odor during agitation and pump-out activities. BMPs are needed and reasonable to further minimize the potential and actual air emissions from liquid storage facilities. At this time, the agency does not have a published list of acceptable BMPs for incorporation into this rule. However, the agency is working with the University of Minnesota Extension Service to develop BMPs that are effective for various types of facilities and management practices. The agency expects thes BMPS to be published in the next two years and, in the interim will provide guidance to owners on a range of BMPs to minimize air emissions.

7020.2003 Water Quality Discharge Standards

Subpart 1. Animal feedlots, manure storage areas and pastures. This provision identifies a specific set of geological conditions and manmade structures or sites that an owner of a feedlot must prevent runoff from entering. This provision is needed because the discharge standards described in the following parts refer to discharges to waters. The prohibited sites which include sinkholes, fractured bedrock, wells, surface tile intakes, mines and quarries, may not be viewed as waters of the state even though they often provide a direct conduit to waters of the state. Because these systems can act to directly transfer pollutants and manure to surface waters, and many persons would not readily recognize the potential impact of these discharges, it is reasonable to prohibit these discharges to sensitive areas and direct conduits to waters of the state.

The provision identifies animal manure, process generated waste water and process wastewaters. This broad approach is needed, for example, to address concerns with milkhouse waste discharges for which without treatment or containment often flow directly to tile intakes, or to slopes and ravines that drain to surface waters. To clarify and ensure that farmers comply with this requirement. Milkhouse waste is wastewater from the dairy milking center. It includes wastes from the milking parlor (manure, feed solids, hoof dirt) and the milkhouse (bulk tank rinse water and detergent used in cleaning). The North Central Regional Extension publication titled, "Pollution Control Guide for Milking Center Wastewater Management" (Exhibit M-33) describes the constituents of milkhouse waste to include cleaning chemicals, organic materials, bacteria, viruses and parasites. The contaminants with the greatest potential to impact water quality are waste milk, cleaning chemicals and manure. These contaminants can affect water quality through the addition of solids, phosphorous, ammonia-nitrogen and chlorides. In addition, the biochemical oxygen demand of milkhouse waste can be as high as 1500 milligrams per liter as compared to 250 milligrams per liter for untreated municipal sewage. Chronic releases of untreated milking center wastewater have been identified as one cause of declining groundwater contamination and could adversely affect drinking water quality and create health hazards. The above mentioned North Central Regional Extension publication highlights the results of Canadian research on milking center wastes. In particular, one study (Miller et al. 1987, paper referenced in Exhibit M-33) estimates that milk room wastes accounted for nearly 12 percent of annual phosphorus discharges from agricultural activities within the Lake Erie Basin. Although circumstances may differ in Minnesota from those in Canada, it can be gleaned from this study that milk house waste has the potential to have a significant impact on Minnesota's water resources.

Subpart 2. CAFOs and facilities with 1000 animal units or more. This provision requires CAFO facilities and other non-CAFO facilities having 1000 or more animal units to meet the federal effluent limitation standards in Title 40 Code of Federal Regulations, part 412 (Exhibit A-13) which for feedlot facilities is no discharge. However, the federal regulations provide the owner of a NPDES permitted facility, after application of best available technology economically achievable, a discharge under the following conditions: "process waste pollutants in the overflow may be discharged to navigable waters whenever rainfall events, either chronic or catastrophic, cause an overflow of process waste water from a facility designed, constructed and operated to contain all process generated waste waters plus the runoff from a 25-year, 24-hour rainfall event for the location of the point source." This provision is needed to clearly state that the no discharge standard is required for all CAFOs. That no discharge standard for all CAFOs is already in MPCA's water quality rules, part 7050.0212, subpart 1. The proposed rule language also specifies that facilities of 1000 animal units or more must comply with the federal discharge standards. As discussed in this SONAR for the definition of CAFO under part 7020.0300, subpart 5a, facilities with 1,000 or more animal units are CAFOs. However, if a facility in this category is determined through a future process to demonstrate that it does not meet the definition of CAFO, the facility would be issued an SDS operating permit. If these owners are determined to be non-CAFOs, they will be issued an SDS permit and required to meet the same discharge standard. This provision is reasonable because it is consistent with federal regulations. For facilities which demonstrate they are not CAFOs and that have 1000 animal units or more, it is reasonable to hold them to the same standard, because the potential for pollution still exists with the volume of manure present and/or handled at the facility. Further discussion of the need and reasonableness of the SDS permit applicability to non-CAFOs with 1000 animal units or more is discussed in this SONAR under part 7020.0405, subpart 1, item B.

Subpart 3. Other facilities. This subpart set forth the discharge limitations for all non-CAFOs (facilities with 0 to 999 animal units), except for those under 300 animal units and eligible for the long-term schedule of compliance under subparts 4 to 6. The referenced standard under part 7050.0215 essentially requires owners not subject to federal regulations to meet a 5-day biochemical oxygen demand (BOD_5) limit of 25 milligrams per liter (based on the arithmetic mean of all samples taken with a calendar month) and if discharging to or affecting a lake or reservoir also meet the nutrient control requirements in part 7050.0211, subp.1. For facilities under 300 animal units some discharge is allowed, provided it meets the effluent limits described above for BOD_5, and nutrient requirements, if applicable. The application of this standard is described below in several examples.

The agency realizes that some of the owners under this category currently maintain a pollution hazard and, therefore, intends that these owners be required to obtain the applicable Interim, SDS or NPDES permit to correct the problems at their facility. An example of an owner that would likely be out of compliance with this provision would be a feedlot housing 400 animal units and having manure-contaminated runoff. Manure originating from the feedlot flows across a barren field and discharges manure solids and untreated manure-contaminated runoff into a stream. A second example of an owner that would be in compliance with this subpart, would be one housing 400 animal units that has manure-contaminated runoff from an open lot, but the manure-contaminated runoff is routed through designed filter strip without having manure solids or manure-contaminated leaving the end of the filter strip. The first example maintains a pollution hazard while the second example complies with this provision by having no discharge.

A critical component in the effectiveness of the filter strip systems is the ongoing operation and maintenance of the systems. The issue of filter strip operation and maintenance, as well as planning considerations and specific design criteria for filter strips, are discussed in the Minnesota Natural Resources Conservation Service draft Filter Strip practice standard, Code 393B (Exhibit T-6). Whether or not a filter strip system is designed according to the NRCS draft standard, the design must provide adequate storage capacity so that use of the filter area is limited to times when the vegetation is actively growing and able to provide treatment of the nutrients in the manure and must also have underlying soils that are dry enough to handle the hydraulic loading or volume of liquid released on the filter. The agency's intent with filter strip systems is that they are designed and operated like a land application site where the nutrient rates and hydraulic loading rates are appropriate for the vegetation and soil conditions present.

A third and more difficult example is where the feedlot is much like the first example above, except that instead of the manure-contaminated runoff entering a stream, the manure-contaminated runoff is routed through a cropped field and dead ends in the field prior to reaching surface waters. Provided that the manure-contaminated runoff does not pond in the field, create an area of stressed vegetation or enter groundwater through shallow bedrock, the manure-contaminated runoff is not likely to create a pollution hazard to surface or ground water and therefore would be in compliance with this provision assuming the agronomic rate requirement is adhered to, and the flow complies with all other applicable rules. The significance of the phrase "corrective or protective measure" in subitem 2 is found in the existing definition, under 7020.0300, subpart 8. The definition states "...a practice or condition...which prevents or reduces the discharge of pollutants from an animal feedlot to a level in conformity with agency rules." The specific agency rule discussed here is the surface water discharge standard located in chapter 7050, which establishes a 25 mg/L BOD_5 limit. Again, the chapter 7050 standard requires that no manure or manure-contaminated runoff from these animal feedlots and manure storage areas may enter surface waters exceeding the effluent limit of 25 mg/L BOD_5.

Finally, the feedlot described in the third example would meet the requirements of this provision, because the manure and runoff from the feedlot would not enter surface waters and would be adequately treated in the cropped field. A subtle, but important, example of the treatment potential and function of a cropped field relates to the direction of tillage patterns relative to the runoff. Consider that a tillage pattern running parallel to the runoff would tend to act as a channel while a pattern that is perpendicular to the flow would tend to distribute the runoff much better. As with the filter systems, operation and management of other treatment systems is important for their success. Grassed waterways, road ditches and channelized flow paths are not considered treatment systems under this subitem because they are included in the definition of waters of the state.

Subpart 4. Eligible open lot feedlots with fewer than 300 animal units. This provision identifies the eligibility criteria for facilities not subject to subparts 2 and 3. It is needed to set the animal unit capacity, operational criteria and registration requirements the feedlot owner must meet to be eligible for the long-term schedule of compliance in subparts 5 and 6. The requirement of 300 animal units or less is reasonable because this number provides consistency with the EPA's 300 animal unit boundary for animal feeding operations and with other sections of chapter 7020 which provide animal unit thresholds that distinguish specific requirements for the different sized feedlots. The provision requires any facility expanding to 300 animal units or more to meet the requirements of subpart 2 or 3, as applicable. As discussed in more detail below, the long-term (2003/2009) schedule of compliance is reasonable for facilities with fewer than 300 animal units because many, if not most, of these facilities have avoided the immediate complete fix requirement of the existing rules because the costs are often too great to bear when considering the short (2 years or less) schedule allowed under the existing frame work of the interim A and B permits issued by the agency and delegated counties. These owners may have also avoided the current program because of the unknowns of what will I have to do and by when. By providing a reasonable and achievable schedule and requirements, the owners will know up front what specifically is required and by when. The provisions under subparts 4 to 6 are reasonable because they provide a realistic and achievable schedule for owners to comply with and allow the agency a much better chance of meeting the desired environmental improvements at these facilities when compared to the current program. This provision further requires the eligible owner to comply with subparts 5 and 6 which identify the interim and final corrective and protective measures necessary to comply with the schedule of compliance. This is needed and reasonable because it directs the owner to the specific requirement that will apply upon meeting and accepting the eligibility requirements.

This provision also requires that portions of a facility that do not meet the eligibility requirements are not eligible for the long-term compliance schedule. This provision is needed and reasonable because the intent is to address open lot runoff problems which cannot be corrected on a short term schedule, and not to allow discharges for example, from a manure storage area or feed storage area to be eligible for the 2003/2009 schedule. This is reasonable because discharges from a feed storage area or manure storage area are typically much easier to address by covering the area open to precipitation or moving the storage area to a new location. Open animal lots are much more problematic to address, because of many factors such as, livestock access to buildings, permanent feed bunks or concrete slabs in the open lot areas and fencing are much more difficult to simply move or cover.

Item A requires that the feedlot be an existing facility. This is a needed and reasonable requirement because the intent is to allow a more cost effective means to install corrective measures and a new facility should not be approved or constructed with pollution problems.

Item B requires that the facility have manure-contaminated runoff from at least one open lot, but that manure-contaminated runoff from the facility cannot create or maintain an immediate threat to human health or the environment under subitem (1) and the facility cannot be a CAFO under subitem (2). The first part that requires manure-contaminated runoff from an open lot relates to the discussion above that areas that are not open lots are not eligible for this compliance schedule. Again, this is reasonable because the intent is to address manure-contaminated runoff problems from open lots. Subitem (1) is needed and reasonable to allow the agency to require corrective actions at an accelerated schedule if actual or imminent threat to waters or human health are observed during an inspection of the facility. Examples of what the agency would consider imminent threats include: a fish kill in a lake or stream resulting from the feedlot runoff; manure-contaminated runoff to a water body where humans swim or are likely to have direct contact; or a manure discharge into one of the areas identified in subpart 1. Subitem (2), which excludes CAFOs from eligibility for the 2003/2009 compliance schedule under this part is needed and reasonable because the case-by-case designation of a feedlot under 300 animal units as a CAFO would likely be undertaken only where a significant pollution hazards exists. Further discussion of the case-by-case CAFO designation process is provided in Exhibit P-3.

Item C requires that the owner be registered according to part 7020.0350. This is needed and reasonable because the agency and delegated counties need the registration information to accomplish the inspection prioritization planning and to have a mechanism for contacting the owners of these feedlots. In practice registration of the facility will most likely be completed at the same time the owner completes the requirements of Item D.

Item D requires the owner to submit a certification form to the commissioner or county feedlot officer that they agree to the conditions of subparts 5 and 6 of this part. This is needed to provide a formal agreement between the owner and the agency or county that the owner accepts the long-term 2003/2009 schedule. This is reasonable because it acts much like an application for a permit, where an owner acknowledges and agrees to the requirements of this chapter when proposing to operate a livestock facility. This is also reasonable because it provides the owner the opportunity to better understand the obligations being placed on him/her as an alternative to the immediately applicable requirements of subpart 3. The certification form will have a provision that provides a conditional waiver of civil penalties for past violations of part 7050.0215 caused solely by passive manure-contaminated runoff from open lots only and for failure to apply for a permit provided the owner maintains compliance with subparts 5 and 6. The term passive is intended to clarify that the civil penalty waiver applies to runoff events for which the owner has not acted to increase or promote manure-contaminated runoff from the lot. For example, a runoff event during a precipitation event without further human involvement would be a passive event. Examples of runoff events that would not be passive events include: if the owner adds to the volume of runoff or concentrations of pollutants in the runoff by stacking manure along the furthest down gradient area in the lot; or has directed water flow to manure covered areas to help flush the lot. This provision is needed and reasonable because it significantly increases the likelihood that a higher percentage of owners in this group will accept this schedule, even though they have not applied for a permit to correct their problems under the current program. If they are otherwise still subject to civil penalties for past violations, they will be much less likely to come forward to the agency or delegated county.

Subpart 5. Interim corrective measures for eligible open lots. This subpart requires feedlot owners that are eligible under subpart 4 to complete one of two relatively low-cost, interim improvement options at the feedlot by October 1, 2003. For the majority of these feedlots, the low-cost improvements identified in this subpart are in the range from $1,500 to $10,000, while a very small portion of these feedlots may have interim improvements that cost up to $20,000. Low-interest loans and government cost share dollars that pay up to 50 percent of these costs are available to many of these feedlot owners. Specific interim options include subitem (1) installation of clean water diversions and roof gutters for areas contributing to runoff from the feedlot and establishing buffer or filter areas having 100 feet or more of non-channelized flow through grasses, or (2) demonstrate that the treatment system achieves at least 50 percent removal of pollutants discharged from the feedlot. Under subitem (1) unit (b), the goal is that the buffer or filter not have channelized flow, visible evidence of manure solids, or areas of dead vegetation during the growing season within 50 feet of the end of the buffer or filter.

In general, the interim improvements are a reasonable approach to this category of feedlots for several reasons. First, unlike the federal regulation of zero-discharge for feedlots having 300 animal units or more and meeting one of two discharge methods, feedlots with fewer than 300 animal units are not held to this same federal standard unless they are designated a CAFO. This allows the commissioner to consider an interim solution for this category of feedlots. Second, a good portion of these feedlots discharge manure to surface waters because they do not have adequate runoff controls in place. Therefore, it is reasonable that 50 percent reduction in manure-contaminated runoff at the estimated 8,000 to 12,000 feedlots in this category, will result in significant environmental improvements on a statewide basis. This is further realized when comparing the current permitting approach that requires a feedlot to make complete improvements that can be significantly more expensive and under the current rules only a small number of these feedlots have an economic situation that allows 100% improvements in any year. These complete fixes are typically designed as collection and storage basins that range in costs from about $40,000 to $90,000 at the majority of feedlots (see Exhibit E-1). In some cases the high-end costs can reach $120,000 or more, especially when a composite liner system is needed because adequate soils are not readily available at or near the site or that minimal separation distance to bedrock is available at the site. This approach has proven to provide incentives for owners to avoid the permitting process altogether, resulting in improvements at only a very small percentage of these feedlots, and a corresponding small effect on overall environmental improvements. Third, by setting the date of October 1, 2003 for completing the interim measures, the provision is reasonable because it allows the feedlot owner adequate time and flexibility to consider multiple options and develop a long-term plan for the feedlot. Finally, this provision is reasonable because this group of feedlots, due to their smaller size, generally do not have the financial resources that the larger feedlots have that are needed to install more costly improvements for a complete fix on a short compliance schedule.

Item A requires owners meeting the eligibility requirements of subpart 4 to operate and manage the facility to minimize discharges of manure and manure-contaminated runoff from open lots at all times. This is reasonable, for example, because it requires owners to scrape manure off open lots on a regular frequency to minimize manure-contaminated runoff from the lot.

The interim improvement requirements under Item B, subitem (1)(a) and (b) which require roof gutters, diversions and vegetated buffer areas or filter strips to be installed and operational by October 1, 2003, are reasonable because these measures minimize the volume of rain and snowmelt water that would otherwise pass through the feedlot or manure storage area and mix with the manure. This clean water diversion in turn results in a significant reduction in the volume of manure-contaminated runoff that must be handled and, because the manure will have a higher solids content, the manure will not be able to flow as easily as it would with a higher water content. Under the second part of this subitem, the treatment distance of 100 feet or more is reasonable because it establishes a clear requirement for owners to achieve. This provision provides an incentive to minimize open manure storage or open lot surface area. Staff believe that 100 feet of treatment distance will be more than needed in some cases and less than needed in others. However, staff's experience indicates that a distance of about 100 feet of non-channelized flow will provide needed interim environmental controls at the vast majority of sites.

The interim improvement requirements established in Item B, subitem (2), which require that the owner demonstrate that the treatment system achieves at least a 50 percent reduction in phosphorus and BOD_5, is reasonable because it again establishes a clearly defined requirement for the owner to achieve. It is also reasonable because, similar to the discussion above, significant environmental improvements will be gained statewide through the approach of 50 percent or better reduction in pollutant loadings at most of the feedlots compared to getting complete fixes at a small percentage of these feedlots.

The most readily available tool for demonstrating 50 percent reduction is the model "An Evaluation System To Rate Feedlot Pollution Potential" (Exhibit M-34) or more commonly known as the Feedlot Model. Using the Feedlot Model for a comparative analysis such as this is a reasonable approach for demonstrating the 50 percent pollutant reduction because it is widely available to private and NRCS design engineers, other technical assistance personnel such as Soil and Water Conservation District (SWCD) staff, county feedlot officers (CFOs) and MPCA staff. In addition, evaluating various corrective and protective measures and rating pollution potential at animal feedlots are the type of application that the Feedlot Model was developed for. Contrary to current understanding by some users of the Feedlot Model, the model was not intended to, and the agency does not acknowledge use of the modeling results to determine compliance with the effluent limits in part 7050.0215. Again, the agency believes this is the best tool available to demonstrate compliance with the 50 percent reduction criterion for interim measures under this part. This provision requires that the modeling be completed by a person who has completed training in use of the model. The model is relatively simple to run including any of the computer program versions or manually. The requirement to have a Feedlot Model-trained person demonstrate the 50 percent pollutant reduction is reasonable because, while relatively simple, the model requires an understanding of the significance of the input values and how to apply each to specific feedlot sites to obtain a meaningful evaluation. Currently, training is available to most NRCS, SWCD and agency staff through the Board of Soil and Water Resources. The agency also intends to provide training in use of the model to the county feedlot pollution control officers.

Staff considered concerns from rule commenters that this option, subitem (2), would be less protective of the environment than the subitem (1) option and should only be allowed if subitem (1) cannot be accomplished at the feedlot. There is a possibility that less than adequate improvements will result at some at feedlots that demonstrate a 50 percent pollutant reduction. The agency intends to consider these facilities on a case-by-case basis through the commissioner's authority to designate a feedlot as a pollution hazard and require corrective or protective measures in an interim permit or by the case-by-case designation as a CAFO process provided in Exhibit P-3. The primary criteria to be used when determining the extent of the problem are, again, if there is an immediate threat to human health or the environment (e.g., a fish kill or discharge to a conduit to drinking waters). The MPCA's intent with this approach is to identify these significant hazards based on a systematic inspection program conducted by MPCA staff and CFOs.

Finally, subpart 5, item B(2) requires the owner to maintain records of the Feedlot Model modeling results until the owner has completed the requirements of subpart 6. The owner is also required to make these results available to the agency or county feedlot officer upon request. This is reasonable because it allows the owner to demonstrate compliance with this provision and provides the agency or county an opportunity to review the modeling records to evaluate how the input values and modeling results compare to actual facility operation.

Subpart 6. Final corrective measures for eligible open lots. The requirements of subpart 6 are identical to the requirements of subpart 3 except that these requirements are triggered in item A upon the October 1, 2009, date; or in item B when the owner chooses to make a change at the feedlot which increases the number of animal units housed at the feedlot. This requirement is reasonable for feedlots expanding in animal number because they likely have the financial resources to install corrective or protective measures to eliminate discharges if they have the resources to expand their facility in animal numbers. It is also reasonable, because it is consistent with the MPCA's current policy on requiring feedlots to eliminate violating discharges prior to completing a planned expansion in animal numbers. The requirement to comply with subpart 2 or 3 upon an expansion in animal numbers applies to owners at any time after the owner has completed the certification form under subpart 4 and agreed to the terms and conditions of this part.

The October 1, 2009, date for completing final corrective measures was selected to provide owners with sufficient time to defer costs of installing final corrective measures over an extended time period. The 2009 date was selected for two primary reasons. First, the agency has viewed the overall feedlot program plan for feedlots, manure storage areas and pastures as an approximate ten-year plan. See Draft Feedlot Program Plan, Exhibit I-4. This plan includes the agency's goal of inspecting all facilities within the state within the ten year period. Second, the year 2009 is the date by which USDA/EPA desire that all animal feeding operations (AFOs) have and are implementing a comprehensive nutrient management plan (Exhibit G-2). Therefore the

2009 date is reasonable because it is consistent with the agency's Draft Feedlot Program Plan and USDA/EPA's AFO Strategy.

7020.2005 Location Restrictions and Expansion Limitations

Subpart 1 contains the agency's proposed restrictions for locating new animal feedlots and manure storage areas near environmentally-sensitive areas or that could become direct conduits to surface waters or ground water. Current feedlot rules do not contain location or setback requirements, yet preventing manure and runoff from manure from entering surface and ground water is essential and a major goal of the feedlot regulations. Location restrictions in the proposed rule will reduce the potential of animal manure runoff that if allowed to enter surface or ground water, can cause serious water pollution. Manure and runoff from feedlots can promote algae and weed growth in lakes and rivers, can deplete oxygen, can be toxic to aquatic life and can pollute both surface and ground water by introduction of large concentrations of nitrates and pathogens.

Subpart 1 prohibits a feedlot owner from locating new feedlots within a shoreland; floodplain; within 300 feet of a sinkhole; 100 feet of a private well; or 1,000 feet of a community water supply well or other wells serving a school or child care center in certain geologic conditions. The specifics regarding the sensitivity of these locations to impacts from manure or manure-contaminated runoff are discussed in detail in the following paragraphs. The proposed rules contain only the restriction needed at a statewide level. These facilities are also subject to any established location standards in local government zoning ordinances. The agency believes that it is reasonable to establish location restrictions in rule to provide a minimum level of protection for all of Minnesota and to provide the feedlot owner information on the agency's expectations. The specific restrictions are reasonable for the reasons provided in the discussion for that standard.

The location restrictions are needed to protect human health and the environment. The agency's basic statutory authorities outlined in Minn. Stat. ch. 116 charge to protect human health and the environment regardless of the program being implemented. Subpart 1 and the other provisions under part 7020.2005 do not establish facility locations based on aesthetic and nuisance conditions, such as proximity to residential development or highways. Aesthetic and nuisance restrictions are under the jurisdiction of local governmental zoning ordinances. The location restrictions in this subpart address impacts of facilities in the areas particularly sensitive to discharges of manure or manure-contaminated runoff.

Geologically sensitive areas are normally considered to be areas where bedrock is susceptible to dissolution and ultimately forming cracks, fissures and large holes visible at the soil surface. This type of bedrock is normally referred to as karst geology and has very little protection from soil covering. Sinkholes, holes in the bedrock, provide a pathway for rapid transmission of surface runoff into ground water, circumventing any treatment or filtering capacity of the natural soil that overlays the bedrock. The 300-foot setback was chosen to increase the amount of pathogen die off and ammonia volatilization before surface runoff can enter the sinkhole. Essentially, as the runoff would move toward the sinkhole, the runoff would seep into the upper layers of soil and be taken up by vegetation, absorbed to the soil particles, or be altered by soil bacteria. The outcome of the natural treatment system is reduced risk to human health and the environment. A setback distance of 300 feet provides an area of natural protection from contaminated runoff that might occur if there is failure of a manure storage system or manure handling equipment. This 300-foot setback does not preclude the project proposer from meeting any of the manure storage requirements of part 7020.2100 pertaining to construction of manure storage areas in karst areas. The 300-foot setback is reasonable because sinkholes are large openings usually at a low spot in the landscape and accept drainage from a broad range. By keeping the facilities farther from the sinkhole, the likelihood that other surface water flow will carry the manure-contaminated runoff to the sinkhole is lessened.

Subpart 1 also establishes a restriction on the proximity of animal feedlots or manure storage areas to private wells. Private wells are owned and used by a single property owner for livestock or human consumption. The definition for private wells is found in the Minnesota Department of Health rules, Minn. R. ch. 4720. Private wells are susceptible to surface runoff of manure, particularly older wells that may not have been constructed under current standards requiring casing and grout. Contaminated runoff that seeps into the ground in the vicinity of private wells can cause acute contamination of the water source. In addition, contaminated runoff may travel into the ground water along the interface of the well casing and the surrounding soil resulting in no treatment of the runoff before it reaches the ground water supply. Therefore, it is important that animal feedlots and manure storage areas not be constructed near wells. The 100-foot setback provides an area of natural protection to allow for pathogen die-off, ammonia volatilization, and seepage into the soil prior to reaching the well.

Restrictions from municipal or community wells are also contained in subpart 1. Municipal wells and community wells are defined in Minn. R. ch. 4720, and usually serve persons or activities outside of the well owner. The number of individuals who could be negatively impacted by a contaminated well is significantly higher with these well types than with a private well. Municipal wells are susceptible to surface runoff for the same reasons as private wells. However, a larger setback of 1,000 feet is required to protect a larger wellhead area. Municipal wells, in particular, pump at higher rate than private wells and thus, any contamination entering the ground water could be drawn to these wells from a larger area as they drawdown the ground water level. This requirement does not preclude tighter requirements that have been developed by municipalities in their wellhead protection area plans as required by the Minnesota Department of Health. The setback is reasonable due to the larger pumping capacity, the greater number of people potentially impacted, and that the distance provides a buffer zone should the municipality need to expand its well field.

Shoreland areas are susceptible to impacts from a number of activities because of the proximity to surface water. The shoreland typically has the potential to be a direct conduit to the surface water for erosion, contaminants, or other types of impacts. Subpart 1 provides a setback restriction to prevent impacts from manure or manure-contaminated runoff. Per the proposed subpart, new animal feedlots or manure storage areas shall not be constructed within shoreland. The restriction is consistent with the Minnesota Department of Natural Resources' Statewide Standards For Management of Shoreland Areas, part 6120.0300, subp. 7, item C, unit 1.

Construction within shoreland areas poses a significant risk to the adjacent waterway if failure or mishandling of the manure management systems were to occur. It is reasonable that the agency's rules are consistent with those rules developed by the Minnesota Department of Natural Resources, which is the agency responsible for managing activities within shoreland areas. Additionally, local zoning authorities also use this restriction as a protection measure and the proposed rule would be consistent with those efforts. It would be unreasonable for the agency to establish a provision that would put feedlot owners in violation of other rules.

Similarly, the agency proposes that a restriction for new feedlots or manure storage areas be established regarding floodplains. Floodplains are areas prone to rapid water movement during flood events. The greater the likelihood for flooding, once in ten years, defines an area as a floodplain. Feedlots need to be located outside of floodplain areas to ensure floodwaters do not impact the feedlot, manure storage structures, or cause manure-contaminated runoff during flood events. Once again, the Minnesota Department of Natural Resources manages activities within floodplains. It is reasonable to alert feedlot owners that the activities associated with feedlots and manure management are not consistent with the state's rules regarding floodplains.

The proposed location requirements were selected in the event that a facility fails to adequately contain the manure it generates, a site's natural conditions can help to protect ground water and surface water, and control migration of the manure if a failure were to occur. For instance, if a manure spill were to occur it would have greater travel distance to permit seepage into before reaching a surface waterbody or other environmentally sensitive receptor.

Historically, feedlots were sited on near surface waterbodies to permit the animals access to water. Additionally, this land was not highly productive cropland when regularly lost to floods or erosion patterns along a streambank. Unfortunately, the same natural conditions that make these sites desirable for siting feedlots also raise the level of environmental risk. Thus, it is necessary for animal feedlot operations to locate where the natural condition will minimize the impact of any manure releases.

Although the facility design and operation provisions require containment and land application of all manure generated on site, these precautions do not guarantee total containment. Releases can occur due to human error in facility operations or a failure in the structural or mechanical components. Corrective actions to contain and recover pollutants are not assured of complete success either. In summary, it would be unwise to rely solely on engineered solutions for protection; but rather, the natural setting must provide a second line of protection.

Item A. Under subpart 1, two special conditions are addressed relative to the restriction standards. Item A establishes an exemption to these location requirements as they pertain to construction in the Red River of the North floodplain. The Red River of the North floodplain is a unique floodplain. This floodplain was created as a lakebed, not a river valley, according to geologists. The floodplain lies in the dried lakebed of glacial Lake Agassiz, and therefore, has very subtle slopes and generally very little change in topography. This flatness tends to exacerbate flooding since there is only a very shallow gradient to promote runoff of snowmelt and precipitation, slowing drainage. There is no topography to constrain flooding, which results in water spreading out over a very wide area. This results in a gradual flooding of large tracts of land. Because such a large area is affected when flooding occurs in this area the Red River is closely monitored and warnings about flooding are giving well in advance of the actual flooding event. This allows residents within the floodplain to take precautions before the flooding event occurs. In addition to the different nature of the flooding in the Red River floodplain, this floodplain encompasses a large area of land of which about 75 percent is in agricultural use. The flooding potential of the Red River of the North is closely monitored and precautions are often instituted before a flooding event occurs. Other floodplain areas in the state are located in river valleys that were carved areas of more topographic change and result in a more rapid flooding that can be devastating to farm structures. Because of the large amount of area encompassed by the flooding, and the difference in the nature of the flooding events in this area it is reasonable to exempt the Red River of the North from this locational requirement. The selection of 1000 feet is consistent with the typical floodplain zone or shoreland setbacks for lakes. While 1000 feet is greater than the shoreland or flood zones associated with rivers and streams, the agency believes it is reasonable to provide a greater zone of protection due to the topography of this watershed. It would be unreasonable to establish the entire floodplain as a restrictive zone, as animal production would be restricted in a large portion of Minnesota's northwestern corner. However, the setback restriction is a figure consistently used in managing activities in this area pertaining to lakes and other surface waterbodies and does not require a change in scope for most activities.

Item B. Item B addresses the re-establishment of feedlots in shoreland areas. One operating practice that owners have employed over the years has been to enter and leave markets for livestock as the prices rise and fall. Under this practice, an owner may raise one type of animal for several years when the market is favorable and raise another when that market is favorable after leaving the facilities for the first animal unused for some time in the process. The proposed rules are intended to allow this practice and still limit owners from reusing facilities that are located in shoreland areas where an animal feedlot or manure storage area should not be located due to environmental concerns.

The proposed definition of "new animal feedlot" means an animal feedlot or manure storage area that existed previously and has been unused for a period of three years or more. With the proposed prohibition of establishing a new animal feedlot or manure storage area in shoreland, the proposed rules would have prohibited owners from using existing facilities that could be slightly older than three years. This could result in a situation where an owner has invested a significant amount of money in the facility and has not been able to recover the cost of the facility.

The proposed rules are intended to allow the owners that have left a market for some time due to unfavorable prices to continue to use the facility and operate in a method that allows the owner to enter and leave markets based on the profitability of the market. The proposed rules are also intended to prohibit an owner from abandoning a facility that is in a bad location and then reopen it many years later. As stated in the Statement of Need, the impact of run off from an animal feedlot or manure storage area in shoreland can have a devastating impact on the water quality. For this reason, it is reasonable to limit the amount of time that an animal feedlot or manure storage area can be abandoned and then reopened. The proposed rules state that if the facility has been unused for ten or more years, that it cannot be reopened. Ten years is a reasonable amount of time to allow owners of these facilities to close and for market reasons. It is reasonable to believe that if an owner is not using a facility for more than 10 years that the cost of that facility has been recovered or written off and new activity at the location should be considered to be a new animal feedlot.

Subitem 1 permits the re-establishment of feedlots in shoreland areas provided the facility has not have been out of operation for more than 10 years and an interim permit is obtained under part 7020.0405. This is needed to reasonably address existing facilities that had substantial capitol investments made in feedlot building and manure storage areas and have only been out of operation for a short time. The requirement to obtain and interim permit ensures that the facility is brought into compliance with the current standards and if the standards are not attainable the reopening of the facility would be prevented permanently. The primary intent of this subitem is to allow the permitting authority to inspect the facility prior to restocking and requiring the owner to take whatever measures are necessary to comply with the technical standards including the discharge standards. For these reasons, the proposed requirement for these owners to apply for and obtain an Interim permit is reasonable. The agency believes this provision to be reasonable as the facilities will meet the proposed technical and operational standards while making use of existing investments.

Subitem 2 expressly resuming operations of facilities located in shoreland areas and out of operation for ten years or more. These facilities would typically require more investment than warranted for the safe operation in a shoreland area. It is also believed that facilities not operating in these areas for more than ten years have in the past experienced difficulty in operating in an environmentally-safe manner and should not be permitted to start up again. The agency believes that a facility not operating for more than ten years is essentially a new facility and therefore, it is reasonable that they be required to meet the locational restrictions placed on new facilities.

Subpart 2 limits an existing feedlot with fewer than 1,000 animal units located in a shoreland area to expand up to 1000 animal units. As discussed in the Statement of Need, the consequences of large amounts of manure can be significant, resulting in fishkills if the discharge is very large over a relatively short period of time or resulting in a waterbody that cannot support fish if the discharge is chronic. The intent of this requirement is to limit the amount of manure that will be present in these areas. For these reasons, it is reasonable to prevent the expansion of feedlots or to require protective measures of facilities that pose water quality hazards.

Feedlot owners will be able to determine the elevation of the ordinary high water mark by obtaining a Protected Water Inventory Map from the local SWCD, Watershed District, County Auditors office, local DNR office, County Zoning office, or County Engineer’s office. If the ordinary high water mark is unavailable from this map, the local Minnesota Department of Natural Resources staff will establish the mark or it can be determined using the following US Army Corp. of Engineers definition. The definition reads: “The "ordinary high water mark" on non-tidal rivers is the line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank; shelving; changes in the character of soil; destruction of terrestrial vegetation; the presence of litter and debris; or other appropriate means that consider the characteristics of the surrounding areas.

Subpart 3 reads as a prohibition for the expansion of animal feedlots and manure storage areas in floodplains except in the Red River of the North floodplain. Animal feedlots and manure storage areas in the Red River of the North floodplain may expand only if the facility is at least 1,000 feet from the ordinary high watermark. The floodplain is estimated to extend nearly 100 miles from the ordinary high watermark. Given the size of the Red River floodplain, it would be reasonable to prohibit expansion within this area.

7020.2010 Transportation of Manure

This provision requires that manure haulers use practices that will prevent the deposition of manure on roadways during transport to land application sites. The existing rule controls pollution from manure hauling equipment by requiring them to be leakproof. While leakproof containers reduce the likelihood of manure spillage on roadways, it does not address other ways in which manure may be deposited on roadways. It does not, for example, address situations where manure, loaded above the level of the containment device, lands on the roadway from wind or cornering or other forces. This type of spillage is as common as problems associated from leakage. The proposed language address all situations by the establishment of a performance standard and not by defining the type of equipment to be used. The proposed language is because the performance measurement allows operators to decide how to meet the standard based on conditions unique to their manure management system. Additionally, the provision is consistent with other agency rules governing the transport of waste materials and the Department of Transportation's rules for transporting waste or raw materials. The negative impacts associated with manure spillage to surface waters indicates the need that this sector be treated like other sectors posing risk to the environment.

Under existing language, roadways that are used for hauling manure from the feedlot to adjacent fields are exempted. This provision has been difficult to interpret. Also, the increase in increase in population of non-farm residences is increasing the traffic on all roads. For these reasons, the agency proposes to delete current roadways exemptions so that the rule applies to all roads.

7020.2015 Livestock Access to Waters Restriction

The agency intends with this proposed part to minimize or eliminate the water quality impact of locating livestock in close proximity to a waterbody so that the livestock do not have body contact with these waters. The primary concerns are manure directly from the livestock either from direct deposition or the animal bathing and thus, removing caked mud/manure from its body. A secondary impact would be manure-contaminated runoff from feeding areas directly along the lakeshore. Since pastures by nature have the potential to produce significantly less runoff, the proposed language focus on the direct access to lakes for animals fed in or housed in pastures. The agency believes provision provides a performance measurement that is flexible enough for the livestock owner to develop a management approach capable of meeting the standard. This part requires that livestock owners prevent or control livestock from entering any lake, which has been classified by the DNR as a natural environment lake, general development lake or general recreational lake. The DNR defines these lakes in Minn. R. pt. 6120.3000. These lakes are most likely used by humans and thus, the deposition of manure directly in the lake will put human health at risk.

When animals enter these lakes, they deposit fecal material directly into these waters creating both a pollution and health hazard. The average dairy cow produces approximately 115 pounds per day of manure, which, if allowed to enter the lake, would contribute 0.57 pounds of Nitrogen and 0.24 pounds of Phosphorus daily to the water. These amounts can have significant impact. It has been estimated that every one pound of phosphorus added to the surface water will generate 500 pounds of algae growth. In addition to the direct deposit of manure from the animal, the shoreland where the cattle congregate and/or enter the lake also becomes eroded and manure packed. This results in sediment and additional manure entering the lake during periods of precipitation.

The state of Minnesota has established a number of rules to protect its lakes from environmental degradation. Since 1974, the state of Minnesota has required proper individual sewage treatment within shoreland areas. This was done in recognition of the significant impact that human sewage could have on the lakes water quality. Animal manure also has a very significant potential for impacting surface water and, therefore, the state of Minnesota clearly needs to address this problem.

Subpart 1. This proposed subpart reads that the owner of any animal feedlot that meets the criteria for CAFO or has a feedlot supporting more than 1000 animal units the livestock must be prohibited entering the identified lakes. Since the federal discharge standard for CAFOs is zero discharge, it is reasonable to propose this prohibition.

Subpart 2. This proposed subpart states that any non-CAFO animal feedlot is required to fence identified lakes by October 1, 2001, to prohibit entry to identified lakes. As stated earlier in this SONAR, manure and manure-contaminated runoff can lead to significant water quality and health problems. For this reason, it is reasonable to prohibit livestock at all animal feedlots from entering the identified lakes. Since these facilities will not have been subject to this requirement prior to the effective date of this proposed rule, it is reasonable to allow the owners sufficient time to comply with this requirement. For this reason, it is reasonable to delay the compliance date. The compliance date of October 1, 2001, was selected because it did not require immediate compliance and yet, eliminated the undesirable practice quickly. Since the solution is likely the installation of a fence, the agency believes that the time frame is reasonable. No agency or delegate county review is required and thus, no administrative oversight should slow the process to control access to the lake.

Subpart 3. This proposed subpart states that any facility that meets the definition of pasture (part 7020.0300, subp. 18) is required to prohibit (item A) or control the access of livestock to identified lakes by October 1, 2001 (item B). The proposed rules require that if the owner chooses to control, rather than prohibit, access to the identified lakes, the control measures must conform to the measures established in Minnesota Natural Resources Conservation Service, Field Office Technical Guide practice codes (Exhibits T-1 and T-2) and the United States Department of Agriculture, Natural Resources Conservation Service, National Range and Pasture Handbook (Exhibit T-3). These methods are intended to minimize the water quality impact of livestock entering and leaving waterbodies by minimizing erosion of the shore and reducing the desirability to the livestock of standing in the water. The agency believes that these methods have been sufficiently reviewed by livestock managers at a national level to ensure they are sufficiently protective. Additionally, the agency believes it is reasonable to incorporate existing practices utilized in other programs that meet the agency's goals to protect human health and the environment.

Proposed part 7020.0300, subp. 18, defines pastures as areas where grass or other growing plants are used for grazing and where the concentration of animals is such that a vegetation cover of perennial grasses or forages is maintained during the growing season and temporary supplemental feeding devices are located outside special protection areas. This proposed definition restricts the use of the term pasture to grass-covered areas, which produce little or no runoff during the growing season. This definition also requires that supplemental feeding device be located at least 300 feet from the waterbody. The proposed setback keeps the livestock from congregating at the shoreline and increasing the erosion and runoff from the area. The proposed rules allow watering within 300 feet of the shore to reduce the cost to pump water to stock tanks. As stated above, the proposed rules are intended to be less stringent for operations that meet the proposed definition of "pasture" to provide an incentive to owners to operate in this manner. Well-managed pastures have significantly less environmental impact than open lots and for this reason, it is reasonable to propose this incentive.

7020.2025 Animal Feedlot or Manure Storage Area Closure

This part sets out the minimum requirements for closure of a facility by the owners once the facility has ceased to operate.

Item A. Item A requires that within one year of ceasing operation, a feedlot owner must remove and land apply manure and manure-contaminated soils in accordance with the proposed land application provisions (part 7020.2225) of this chapter. This subpart sets out the procedures necessary to close an animal feedlot operation in a manner that protects human health and the environment. This time frame should not be a burden to owners or operators since manure is typically removed annually at most feedlot operations. Also, it is advantageous to the owner to land apply manure before it declines in nutrient value. It is reasonable that the agency establish expectations for the proper closure of these facilities. The time frame of one year was selected to ensure that the facility was properly closed to reduce risks, but allowed the feedlot owner the opportunity to properly land apply the material when it would be most valuable in terms of nutrients and availability to crops.

Item B. In item B, the agency requires the owner to establish vegetative cover to facilitate more nutrient uptake and prevent erosion and runoff. Item B also requires the owner to maintain this vegetative cover for at least five years. While it's not possible to say that five years will remove all of the excess nutrients or that five years is longer than is necessary, this time will remove a significant amount of the nutrients and is not excessively long because the crop taken from this land will have value.

Items A and B are both reasonable because if left untreated concentrations of manure and nutrient overloaded soil could pose potential ground-water problems through leaching and surface-water problems through run off.

Item C. Under item C, the agency requires the facility owner or operator to notify the commissioner or CFO at least 60 days after closure of the facility. The notification is needed to allow the agency or delegated county to verify that the facility has been closed according to the requirements in items A and B. The agency needs verification because it is responsible to ensure closure activities are completed in a manner that protects human health and the environment. It is reasonable that the agency and CFO understand that a facility is no longer in operation and has been closed properly.

7020.2100 Liquid Manure Storage Areas

The existing feedlot rules require plans to submitted with a permit application for proposed manure storage structures (existing part 7020.0500, subp. 2, item C). The existing rule requires that only plans for structures of 500,000 gallons capacity or greater be prepared or approved by a professional engineer or Natural Resources Conservation Service (NRCS) employee. The proposed rule, part 7020.2100, will primarily codify current program practices and policy and formalize many of the specific provisions currently used by the agency and delegated counties during the review of permit applications and processing of interim, SDS and NPDES permits issued for proposed liquid manure storage areas. This part is needed to provide predictability and reliability to the regulated parties and is reasonable because it makes these requirements readily available for owners and the general public. This section is essential for the program as a whole when considering the proposed modifications to the permitting program, under which not all owners are required to apply for and obtain a permit prior to constructing. This part will also assist the agency and some delegated counties in improving permit application review and issuance times and focusing resources on facilities that pose the greatest environmental risk and greater field presence. These issues were both identified in the Program Evaluation Report by the Legislative Auditor as areas needing improvement in the current program. See Exhibit G-1. The agency has also drafted feedlot program goals to address the issues of field presence and permit review and issuance time. See Exhibit I-4.

In general the need and reasonableness of the provisions in part 7020.2100 relate to the hazards to groundwater posed by storing liquid manure which were also discussed in this SONAR, but are discussed briefly here to highlight the specific issues related to storing liquid manure. Manure contains a number of materials which have the potential to pollute ground water including compounds which may be converted to nitrate, as well as microorganisms that may cause disease in humans that consume ground water as a drinking water supply. The following are primary drinking water standards for compounds or microorganisms that may be associated with manure. See Exhibit M-22.

Nitrate	10 mg/1
Total coliform organisms	1 most probable number per 100 milliliters

While typically manure contains very low concentrations of nitrate, it does contain very high concentrations of nitrogenous compounds such as ammonia, urea, uric acid, and other organic forms of nitrogen, which may be converted to nitrate by microorganisms in the soil. Nitrate is readily used by plants or some soil microbes. However, ground water can leach nitrate out of the plant rooting zone in the upper layers of the soil, and eventually move to an aquifer. Nitrate generated from materials leached from the manure storage system and carried by ground water flow to a drinking water source may create potential human or livestock health effects. In particular, babies consuming drinking water that exceeds 10 mg/1 nitrate may develop methemoglobinemia, or "blue-baby syndrome," which can be fatal.

There are a number of other parameters monitored in ground water to detect manure-related pollution, including chloride and sulfate, for which there are secondary drinking water standards. Pollutants such as phosphorus can be transmitted in soluble form through ground water and may in some circumstances return to surface waters. See Exhibit M-23. There may also be pathogens (disease-causing microorganisms) in the manure such as Escheri coli, Salmonella, and Cryptosporidium. See Exhibit M-24. While soils can act as a "filter" to trap bacteria and protozoans to prevent movement to ground water, microorganisms may still travel through macropores in the soil such as fractures, earthworm burrows, or decayed root channels to shallow aquifers that may be in contact with drinking water supply wells. This can result in these microorganisms being transported through the drinking water system, particularly if contaminated ground water enters defects in well casings. See Exhibit M-25. Analysis for fecal coliform bacteria serves as an indicator that fecal material is present in the water source, and that pathogens could be present in the water sampled. Discharges to surface waters from spills also are a concern.

Phosphorus in various forms is also present in manure. Aquatic plant growth in most surface waters is limited by phosphorus concentration, and additional inputs from manure in runoff or from a discharge from manure-storage systems will result in increased aquatic plant production. This can increase the rate of eutrophication of lakes and wetlands, and decrease water clarity. Manure can also increase the level of total suspended solids and turbidity in the surface water.

In addition, livestock production-related materials such as antiseptics, antibiotics, footwash materials, etc., may be put into the system along with the manure. These can be a direct hazard to water, if leached from the storage system or discharged into surface waters. In order to limit and minimize the potential for pollution of ground water from the nitrate, phosphorus, bacteria and other hazardous compounds, it is needed and reasonable to require that liquid manure storage areas be designed, constructed and operated according to the standards required in this part. The need and reasonableness of each subpart is described in more detail below.

Finally, MPCA staff, with assistance from consulting engineers, government agency staff, producers and manure management consultants, have discussed policy issues related to earthen manure storage basins and other liquid storage structures which are summarized in the following documents:

- Animal Manure Storage Pond Groundwater Quality Evaluation (Exhibit M-4);
- Manure Storage Criteria and Policy Development in Minnesota (Exhibit M-5);
- Effects of Clay-lined Manure Storage Systems on Groundwater Quality in Minnesota: A Summary (Exhibit M-1);
- Seepage From Earthen Manure Storage Systems (Exhibit M-3);
- Clay-lined Earthen Manure Basins (Exhibit M-2); and
- MPCA Soils Investigations for Feedlots and Manure Storage Facilities (Exhibit M-26).

The agency has also developed guidelines to assist designers and regulatory staff in the development and review of plans and specifications. These guidelines incorporate recent research and are derived, in part, from the Natural Resource Conservation Services (NRCS) Standards 425 (Exhibit M-15) and 313 (Exhibit M-9), and from meetings and work products of the Feedlot and Manure Management Advisory Committee's. Many of the provisions in the guidelines and of this rule part are based on recommendations of the FMMAC concrete and earthen basin task forces. FMMAC's Concrete Manure Storage Task Force and Earthen Basin Task Force assisted in the development of the following:

- MPCA Guidelines for Concrete Manure Storage Structures (Exhibit M-11);
- MPCA Contractor's Inspection Record of Manure Pit Construction (Exhibit M-16);
- MPCA Photographic Inspection of Concrete Manure Storage Pits (Exhibit M-17);
- MPCA Guidelines for Design of Cohesive Soil Liners for Manure Storage Structures (Exhibit M-18); and
- MPCA Guidelines for Alternative Liners for Earthen Storage Structures (Exhibit M-14).

Subpart 1. Subpart 1 sets out the content of this rule part which is the permitting, design, construction and operation of liquid manure storage areas. Subpart includes three requirements: (1) that, except those meeting the site restrictions of subpart 2, all liquid manure storage areas must be designed constructed, maintained and operated according to subparts 3 to 7; (2) that owners must submit a permit application as applicable in part 7020.0405; and (3) that owners not required to apply for a permit must complete the notification requirements of subpart 5. These provisions are needed to inform the owner that this part applies broadly to design, construction, maintenance and operation of liquid manure storage areas, and not just to owners that are required to obtain a permit. These provisions are reasonable because they direct the owner to the applicable section which may apply to their liquid manure storage area.

An important requirement of this provision is that owners must submit their plans and specifications to the commissioner or delegated county feedlot pollution control officer. For this example, the inclusion of the reference to subparts 3 to 7 is reasonable as it directs the owner to subpart 4 where the requirement to submit plans and specifications is expressly stated. This is appropriate as the agency or delegated county has authority to review proposals for construction of manure storage areas, which is needed to ensure that these storage areas are designed, located and will be constructed in a manner consistent with the applicable technologies in order to prevent pollution of ground and surface waters.

The requirement in this part to submit plans to the agency or delegated county are also in the facility owner's best interests. The owner is prohibited from beginning construction until the permit application has been reviewed and approved in the form of a permit or the owner has not been asked to modify the proposed design if no permit application is required. In this way, potential sources of negative impacts on water quality will be better identified and controlled or minimized. In addition, the MPCA has the opportunity to assess the likelihood of any potential future damage to the structure. The opportunity for agency review may provide additional protection to the owner from potential financial loss that might result if construction were to begin and the structure was later determined to be in non-compliance as a result of site or structural deficiencies. Ultimately, the responsibility of proper design and construction lies with the operator/owner along with any liability for environmental damage resulting from these structures. The agency intends to conduct a summary review on the majority of these plans and specifications, while focusing staff resources and review efforts on the proposals, which present the greatest risk to the environment. It would seem, therefore, reasonable and desirable to have the agency or delegated county advise and assist the owner and design engineer during design process instead of waiting until the formal review process following submittal of the plans.

Subpart 2. Subpart 2 lists four main geographical situations where construction or expansion of liquid manure storage areas is prohibited. An exception is made when construction or modification is required to resolve existing pollution hazards at a feedlot having fewer than 300 animal units. The need and reasonableness of this exception is described in this SONAR under item C. The location and expansion restrictions under part 7020.2005 are referenced in this provision to clarify that those restrictions apply to this part. The need and reasonableness of these restrictions is described in this SONAR under part 7020.2005. In summary, referencing part 7020.2005 here prohibits liquid manure storage areas within a 100-year flood plain as structures located within the floodplain may be damaged or inundated from floodwater and within shoreland as provided in part 7020.2005, subparts 1 and 2. The floodplain provision will eliminate one of the highest-risk pollution threats created as a result of manure storage location. A 100-year floodplain area has a one in 100 chance of flooding in any given year. Thus, it is inappropriate to build a storage structure in such an area where it can potentially be damaged by flood water, and potentially result in large quantities of manure to be carried away by flood water. The shoreland provision minimizes the potential for surface water pollution from manure and process wastewater discharges.

Item A. In item A, the agency proposes to prohibit construction of liquid manure storage systems with a capacity of more than 250,000 gallons where geologic conditions are suitable for sinkhole development and where four or more sinkholes exist within 1000 feet of the proposed site. In order to trigger the criteria in this provision, the facility has to have four or more sinkholes within 100 feet and be in a geologic setting suitable for sinkhole development. This is reasonable because a facility within 1000 feet of four sinkholes and located where the first bedrock encountered is the Jordan Sandstone or a stratigraphically lower unit. It would be unreasonable to limit construction at that facility because the underlying bedrock unit results in little to no potential for karst sinkhole development. The 250,000-gallon limit in this provision is reasonable to minimize the probability of negative impacts resulting from sinkhole formation under a liquid manure storage area causing a failure of the system and to minimize the degree of negative impact resulting from failure of a liquid storage area liner. The larger the liquid storage structure, the greater the probability that a failure will occur. See Exhibit M-27. If failure occurs, the 250,000-gallon limit also limits volume of manure reaching waters of the state. The agency has also developed draft guidance to further address the issue of reducing the environmental risks associated with constructing liquid manure storage areas in the karst region. See Exhibit M-13.

In item B, the agency proposes to set minimum separation distances to bedrock in the karst region for construction of liquid manure storage systems. These proposed restrictions are needed to reduce potential water quality risks associated with constructing liquid manure storage systems in those areas, which are the highest risk for failure. The current rules do not directly address sinkhole risks and separation distances to bedrock in the karst region.

Three potential water quality risks associated with liquid manure storage systems in the karst region include: 1) seepage of contaminants through the liner and underlying soil to fractured bedrock and subsequently to ground water; 2) soil subsidence below the structure which breaches the integrity of the concrete, geosynthetic or soil liner, causing a slow and perhaps undetectable leaking of manure from the storage system to ground water; and 3) a large sinkhole forming below a manure storage system leading to a rapid flow of manure into ground water or causing a collapse in a basin sidewall and a pouring out of manure onto the ground surface. Item A addresses the risks associated with the second and third risk noted above. Item B affects the risks associated with all of the above stated risks of constructing liquid manure storage systems in the karst region.

Manure entering ground water will discharge into streams within a period of time ranging from hours to decades depending on the site-specific hydrogeology. The karst region of Minnesota maintains a large number of high quality trout streams. A rapid discharge of a large quantity of manure into a stream will destroy the aquatic life for a stretch of the stream and also result in increased nutrient loading into the receiving waters of the Mississippi River system. Manure which flows in the ground water for a longer period before discharging into streams will be more diluted and may not destroy aquatic life, but will threaten drinking water supplies as it travels toward the stream, and contribute to stream pollution upon discharge.

Between 1974 and 1992, sinkholes opened below three of the twenty-two municipal wastewater treatment ponds in Minnesota's karst region. Sinkholes developed in Altura's ponds in 1974 during construction and in 1976 when it first filled to capacity. A sinkhole developed in a Lewiston pond in 1991 after eighteen years of use. Several sinkholes developed in a Bellchester pond in 1992 after twenty-two years of use. The amounts of partially treated wastewater draining into sinkholes at the three respective sites was 3.7, 2.3, and 7.7 million gallons. The ponds were constructed of earthen materials with a designed theoretical seepage rate not to exceed 3500 gallons per acre per day, and they were constructed in areas with less than 20 feet to bedrock.

These failures clearly demonstrate the potential for sinkholes to develop in southeastern Minnesota when large quantities of liquids are stored in sinkhole prone areas with minimal barriers between the liquid and underlying materials. Similar problems could develop when storing liquid manure on top of permeable liner materials. There are some notable differences between these failed municipal wastewater treatment systems and manure storage systems currently being constructed. The maximum allowable design seepage rate proposed for earthen manure storage systems is 1/56 of an inch per day, seven times less than the old municipal wastewater ponds. It is also important to note that the contaminant concentrations in manure are often over 100 times greater than municipal wastewater pond liquids, and thus the environmental consequences of a catastrophic manure release could be much worse than municipal pond failures.

Sinkhole mapping and research completed during the past two decades has made it easier to determine the relative soil subsidence risks when siting new liquid manure storage systems in Southeastern Minnesota. Sinkhole probability maps have been completed for three counties and additional hydrogeologic investigation has been conducted in the other karst areas. The probability of sinkhole formation has been found to vary tremendously across the region. Some areas have in excess of 50 sinkholes per square mile and other areas have no sinkholes. Often high density clusters of sinkholes are adjacent to areas with scattered individual sinkholes. Bedrock composition, topographic position in the landscape and thickness of glacial materials over bedrock have all been found to affect the likelihood of sinkhole formation.

Most sinkholes in southeastern Minnesota appear where there is less than 40 to 50 feet of surficial cover over carbonate and sandstone bedrock. The proximity of nearby sinkholes are the single best predictor of new sinkhole development. On a scale of several kilometers, new sinkholes in Winona County have tended to develop in the areas of existing sinkholes, especially near newly developed sinkholes.

Item A. In item A, the agency prohibits construction of liquid manure storage systems (over 250,000 gallons) in areas, which clearly show historical evidence of soil collapse and formation of sinkholes. Item A is needed to prevent construction of large liquid manure storage systems which can pose a great risk to water quality when located in areas where soil collapse is likely. Item A is reasonable because 1) areas of such high sinkhole densities are limited in the karst region; 2) storage systems can still be approved above 250,000 gallons in such areas to resolve existing non-compliance issues at feedlots in accordance with Item C, and 3) manure storage systems holding less than 250,000 gallons could still be constructed. Where four or more sinkholes are found within 1000 feet of a proposed liquid manure storage system, but the geologic conditions change between the sinkholes and proposed site so that conditions are not suitable for sinkholes at the proposed site, then construction of liquid storage exceeding 250,000 gallons may be allowed.

Item B. Proposed restrictions in Item B will limit construction in many other vulnerable sites in the karst region. The minimum depth to bedrock required in Item B depends on the size of the manure storage system as determined by the volume of manure and process wastewater contributing to the storage system, and the type of liner to be used. Greater separation distances to bedrock are required for larger facilities, because the risk of a sinkhole forming, soil subsidence or ground water contamination is greater for a larger facility than a smaller one, assuming all other things are equal. Use of a concrete or composite liner will reduce seepage rates and can be expected to result in a reduced risk of inducing soil collapse compared to a cohesive soil liner. In addition, a concrete or composite liner will be expected to seep less and therefore not need as much underlying soil for removal and treatment of contaminants.

Item B is reasonable because it still allows for construction of liquid manure storage systems in many areas of southeastern Minnesota. The concrete and composite liners are currently in common use in this part of the state, and the separation distances will reduce the risk of soil collapse below a manure storage system and will allow for treatment of contaminants which seep through any liner materials. In addition, in accordance with Item C, exceptions can be made to resolve existing non-compliance issues. Subitems 1, 2 and 3 describe proposed separation distances for three different size categories of feedlots, 1) less than 300 animal units, 2) 300 to 999 animal units and 3) 1000 or more animal units. Thresholds in Item B based on animal units thresholds were chosen to conform with other parts of the rules which are based on these same animal unit thresholds.

Where soil and geologic conditions are not suitable for sinkhole formation, then the proposed requirements in item B would not apply. These proposed requirements are for construction of new liquid manure storage systems, and do not pertain to existing manure storage structures.

While liquid manure storage systems can increase risks for ground water, these systems are overall a favorable option for water quality since they prevent runoff of manure to surface waters and increase the probability that the manure can be applied to cropland in a safe manner. The proposed separation distances were chosen to significantly reduce the risks to ground water associated with constructing liquid manure storage systems in the karst region, yet make it feasible for most farms to construct manure storage systems. There will, however, be many areas where the separation distance will not be attainable for below ground systems adjacent to existing farms. In these locations, the producer may pipe manure over to a location where adequate separation distances are found, or manage manure as solids, or construct an above ground manure storage system such as a steel slurry store which is lined with a material to prevent corrosion.

Subitem 1. For feedlots with less than 300 animal units, the agency proposes to require a minimum of five feet of separation distance from liquid manure to bedrock and to require in areas with less than 20 feet of separation to require a concrete-lined, above ground or composite lined system be used.

Subitem 2. In subitem 2, the agency proposes to require separation distances from manure to bedrock at all feedlots with 300 to 999 animal units to be 30 feet or more when using cohesive soil liners, 10 feet of more when using a composite or concrete liner, and 5 feet or more when using either an above ground manure storage area, concrete underlain by a secondary liner, or composite liner with three feet of compacted cohesive soil below the synthetic liner.

Subitem 3. In subitem 3, the agency proposes to require separation distances from manure to bedrock for new storage systems at all feedlots with 1000 or more animal units to be 40 feet or more when using cohesive soil liners, 15 feet of more when using a composite or concrete liner, and ten feet or more when using either an above ground manure storage area, concrete underlain by a secondary liner, or composite liner with three feet of compacted cohesive soil below the synthetic liner.

The proposed requirements in item B, subitems 1 to 3 are needed to provide increased levels of ground water protection as natural soil protection diminishes, and to provide increased protection for liquid manure storage at larger feedlots. These proposals are reasonable for the reasons previously stated.

Item C. Under item C, the agency proposes to allow an exemption to the site restrictions in part 7020.2005 and items A and B if the system is being constructed as a pollutant abatement system to address a pollution hazard at an existing facility having fewer than 300 animal units. This is reasonable because the relative risk of ground water pollution from a new or modified manure storage basin in these restricted areas is much smaller than the risk to surface water quality from ongoing manure-contaminated runoff from open lots, for example. Furthermore, a storage basin may be the best or only feasible option for addressing the runoff problems at the facility when the alternative is closure or abandonment or the facility. This provision does not allow facilities with 300 animal units or more an exemption to the site restrictions in part 7020.2005 and items A and B. However, these owners may apply for an NPDES or SDS permit under part 7020.0405, subp. 1, to modify a liquid manure storage area if the existing liquid manure storage area is determined to be a pollution hazard.

Subpart 3. This subpart contains the basic requirements for liquid manure storage area liners including minimum storage capacity, liner requirements and prohibited liner penetrations.

Item A. Item A requires that new or modified liquid manure storage areas at facilities with 1,000 animal units or more be designed to provide for a minimum of nine months of storage capacity. Due to factors such as weather, soil conditions, crops and the owner's schedule, a small window of opportunity may exist to land apply the manure. This provision is needed to provide owners with a relatively large volume of manure the flexibility to deal with the range of outside factors and enhances the opportunity for the manure to be spread at agronomic rates and in an environmentally sound manner. This provision also lowers the risk of basin overflow. This provision is not intended to require all new liquid storage areas to have nine months storage capacity, provided the storage capacity at the facility as a whole is at least nine months. For example, a dairy facility of 1200 animal units could build a one-month storage pit from which the manure could be transferred to the main storage area which has (or would have) at least 9 months storage capacity. This provision is reasonable because it provides an adequate storage volume to minimize the land application of manure and waster waters during the winter months when runoff problems are most likely due to frozen or snow covered soils. The agency's recommendations are for owners to design liquid manure storage areas for a storage term of seven to 12 months. See Exhibit M-18. The vast majority of new liquid storage areas proposed since about 1993 include provisions for 12 months of storage capacity. Designing for 12 months capacity has been the trend in recent years primarily to give the owners greater flexibility in managing and land applying their manure. This issue is also addressed and recommended by the American Society of Agricultural Engineers (ASAE) in ASAE Engineering Practice EP393, "Solid and Liquid Manure Storages," section 2.2.1.1. See Exhibit M-6. While the ASAE standard recommends only 180 days, the agency's experience has been that it is often difficult for owners to get into the fields to land apply the manure in spring or fall due to wet soils conditions. Therefore it is reasonable to extend the ASAE recommendation into the rule to 9 months to provided added assurance that owners of facilities over 1000 animal units have adequate flexibility to properly manage liquid manure.

Item B. This provision identifies the requirements for various liquid manure storage area liner systems. In some settings, unless a liner is installed to limit seepage, leakage from below-ground manure storage systems may pollute ground water as discussed above. Numerous studies, cited in a literature review by Parker, et al., have indicated elevated manure-related pollutant concentrations down-gradient from unlined manure storage systems, particularly in soils which have a rapid rate of permeability, or where fractured bedrock is present. See Exhibit M-28. A substantial number of projects in Minnesota where the basin is greater than about one-half acre in surface area have encountered permeable, water-bearing soils during construction.

Studies have indicated that biological and physical seals can develop to retard the movement of pollutants out of unlined storage systems. Physical seals are those formed by solids in the stored waste plugging the soil pores and restricting flow. Biological seals are a layer of microorganisms that form near the stored waste and may use nutrients seeping out of the storage system. Both will restrict seepage out of the storage system or, alternatively, will change pollutants leaching from the system into compounds that are not of a concern from a ground water perspective. Studies of physical and biological seals have reported that these seals take from 6 weeks to 6 months to form. See Exhibit M-29. However, these seals are not uniform; they may not restrict flow as much as properly installed liners; and can be damaged by various physical and chemical forces that may increase leakage. See Exhibit M-25.

It has been observed that a liner is necessary for manure storage systems to protect ground water in areas where there are soils of rapid permeability, particularly where there is a potential for water-bearing sand or gravel layers. In summary, the primary reasons for the liner are:

- Manure contains pollutants which can degrade ground water quality;
- Impacts on ground water from manure storage systems have primarily been observed in soils of rapid permeability where no liner was installed to retard seepage;
- Seepage from the system will preferentially flow through more permeable soils;
- Soils of rapid permeability (e.g., layers of poorly-graded sands and gravels) are present at shallow depth in much of Minnesota, in both small and large deposits;
- Sand and gravel layers or "lenses" can readily transmit ground water, and can serve either as aquifers or reservoirs to recharge ground water; and
- Sand and gravel layers or "lenses" may also transmit ground water back to surface water at ground/surface water interfaces such as ditches, streams, lakes, etc.

Based on these factors, it is reasonable to conclude that installation of a liner to restrict seepage from manure storage systems is required in order to protect ground water where water-bearing soil layers exist. Because installation of a liner will eliminate or limit seepage of pollutants through soil macropores that can serve as conduits for ground water flow, while native soils generally will not, it is reasonable to require a liner to be installed in liquid manure storage areas.

Subitem 1. Under subitem 1, the seepage standard of 1/56 of an inch per day (or 500 gallons per acre per day) throughout the design life of the structure is specified. Five hundred gallons per acre per day, or 1/56 inch per day, is the maximum seepage limit set for municipal stabilization ponds and industrial wastewater ponds in Minnesota, by the MPCA's Recommended Design Criteria for Stabilization Ponds, March 1993 (Exhibit M-8) and is also the required standard in the Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, Recommended Standards for Wastewater Facilities, 1997 Edition, Chapter 90, Section 93.422, Exhibit M-30). The agency has also required this seepage standard to be met under the existing program and has issued permits for these types of structures and incorporated requirements for meeting this standard in these permits. See Exhibit M-18. An example of one such permit is provided in Exhibit M-19. This limit is based on potential impacts of stored wastes on ground water considering dilution and practical considerations of material available for construction of liners. Therefore, it is suggested that this be adopted as design seepage limit standard for manure storage systems. Five hundred gallons per acre per day is approximately the same as 1/56 inch per day. The amount of seepage that will occur from a liquid storage system depends on the depth of the liquid in the structure, the thickness and type of liner material used, liner damage that has occurred, and type of underlying soil. Sidewalls are the areas most prone to damage. Liner materials that are capable of restricting seepage to 1/56 of an inch per day or less, if installed and maintained properly, include:

- Recompacted (remolded) cohesive clay-type soils, typically with a Plasticity Index of between 10 and 30 percent and hydraulic conductivity of 10^{-7} cm/sec or less;
- Flexible membrane liners (plastic or rubber);
- Geosynthetic clay liners;
- Concrete (designed and constructed as in subitem (2)); and
- Corrosion-resistant steel manure tanks (e.g., glass lined).

As described, earlier in this section of this SONAR, the agency has provided further guidance on siting, design and construction of these liner systems. See Exhibits M-14, M-17, M-18, M-31 and M-32.

Subitem 2. The agency specifies the concrete liner requirements as needing water stops or joint sealant materials in all construction joints, and sealing of all cracks which may extend through the concrete liner. Requiring sealed joints and cracks is needed and reasonable because staff have observed several cases for which structures built without these standard materials and methods for liquid storage result in excessive seepage which has been observed at the interface of the concrete floor and vertical wall. The agency has also experienced several projects where the structure failed a water balance test prior to sealing the joints and cracks. The water balance test basically defines a failure as the pit could not be statistically demonstrated to meet the 500 gallons per acre per day standard. On one occasion, the contractor had to seal the joints and cracks several times to achieve a passing water balance test. This example is not the norm; however, it does demonstrate that even under high quality concrete work and sealant efforts a significant potential for excessive seepage from the structures exists. This provision is also reasonable because it provides consistency with the USDA, NRCS Conservation Practice Standard, Waste Storage Facility Code No. 313, which requires concrete liners to have non-metallic water stops in all construction joints. See Exhibit M-9.

NRCS Code 313 also requires that the floor thickness be a minimum of 5 inches and have reinforcing steel based on American Concrete Institute (ACI) 360, "Design of Slabs on Grade." The proposed rule provision, which mirrors this requirement, is needed and reasonable because it provides consistency for all concrete structures built in Minnesota and provides the necessary structural elements to achieve a liquid-tight structure. The NRCS Code 313 further specifies the steel requirements as:

> "The minimum reinforcing steel area shall be 0.15 percent of the cross-sectional area of concrete. Maximum reinforcing spacing shall be 24 inches. Reinforcing steel shall be supported in its intended location by appropriate chairs or concrete blocks. Reinforcing steel shall be deformed reinforcing bars. Welded wire reinforcement shall not be used."

The agency intends that the above requirements of NRCS Code 313 be followed when designing and constructing concrete manure storage tanks. Again, this is reasonable to provided consistency for concrete pits constructed in the state. This allows a contractor to use the same construction methods and practices from site to site, which under the current program is not taking place. Several engineers design pits with reinforcing steel, while others do not. Several counties already require a five-inch thick steel reinforced floor while the state program has only a policy of 4 inches. This consistent approach will ultimately provide higher quality structures and better assurance (because of the liquid-tightness standard) that the structures are not impacting ground water. The agency believes that these requirements will result in construction of concrete manure storage areas which achieve or exceed the seepage limiting requirements of the Non-concrete liners discussed in subitem 1. The use of a method specification for this subitem is needed and reasonable because there are no reliable theoretical methods to estimate the seepage from concrete structures where cracks and joints dominate the seepage characteristics.

Subitem 3. The agency proposes in subitem 3 that all composite-lined or above-ground manure storage areas be designed and constructed to achieve a theoretical seepage rate of not more than 1/560 inch per day, which equates to about 50 gallons per acre per day throughout the design life of the structure. Much like the need and reasonableness of the 1/56 inch standard in subitem 1, this standard is needed and reasonable to further limit the seepage from liquid storage facilities in areas that are highly sensitive to ground water contamination including the karst situations identified in subpart 2, item D. This seepage rate standard for composite liners has been demonstrated to be achievable under liner installations defined as good to great (course notes from David Daniel, Clay Liners and Geosynthetic Clay Liners for Manure Storage, February 1997. See Exhibit M-20. As discussed in this SONAR under subpart 2 items C and D, requiring a lower permeability liner in the areas susceptible to sinkhole formation is reasonable to minimize the likelihood of sinkhole formation and, therefore, a catastrophic failure

Item C contains specifications for the liner design that are needed to protect the integrity of the liner. Specifically, no water supply systems, fuel lines, electrical conduit or other equipment, apart from the manure handling or transfer system, may be designed or constructed to penetrate the liner of a manure storage structure. This is a reasonable request as the producer has a considerable investment in the liner, which will be compromised if equipment penetrates it. Manure would then have a conduit from the containment structure and ground water or surface waters could be threatened. If piping or equipment functioning as part of the manure handling or transfer system penetrates the liner, then it must be identified in the design plans and specifications. The design plans must include details on the location and purpose of the penetrations, including their dimensions and the methods and materials used to provide a seal between each penetration and the liner. With properly identified and sealed penetrations, the investment by the producer and the environment will benefit. This item is reasonable since it allows for penetrations necessary for a properly functioning system as long as provisions are made for sealing spaces between the object penetrating the liner and the liner materials.

Subpart 4. Subpart 4 lists the manure storage structure plans and specifications that are required for the construction or modification of a liquid manure storage area. The provision requires that these plans be submitted with a complete permit application or at least 90 days prior to commencement of construction if no permit is required (i.e., for a facility under 300 animal units). This provision is needed to allow the agency or delegated county the opportunity to review the proposed project and to have the plan available when conducting an on-site inspection during construction. Submittal of these plans is reasonable because it requires that the owner have the critical planning and design elements of a proposed project completed well before commencing construction. Submittal also allows the agency or county adequate time to review and allows the owner adequate time to address any design concerns or non-compliance with these standards prior to commencement of construction.

This provision also requires plans and specification for liquid manure storage structures having a capacity of more than 20,000 gallons to be prepared and signed by a registered professional engineer or NRCS staff person having approval authority for the project. This provision is needed to address the requirements of Minn. Stat. § 116.07, subd. 7j, and it states:

> “Until new rules are adopted that provide for plans for manure storage structures, any plans for a liquid manure storage structure must be prepared or approved by a registered professional engineer or a United States Department of Agriculture, Natural Resources Conservation Service employee."

This provision is reasonable because it continues the requirement for a registered engineer of NRCS staff person to prepare and sign the plans, but also allows smaller pits of 20,000 gallons or less to be installed without this signature requirement, provided the other requirements of part 7020.2100 are complied with. This is further reasonable because it saves the owners building small pits from paying typical engineering costs for preparation and signature of plans from $1,500 to $5,000, depending on the size of the structure. An estimated cost of installing a 20,000 gallon pit ranges from $5,000 to $15,000, which would result in a conservative estimate of 10 percent of the overall costs going to the engineer's signature for the plans. Finally, this requirement is reasonable because it encompasses many of the smaller, often pre-constructed pits such as septic tank pits, which may be used at facilities for very short-term storage. It would be unreasonable to require these pits to have an engineer's signature, when typically they have already passed engineering design standards and testing at the plant where they were manufactured.

Item A. Item A contains the content list for the required preliminary site investigation. The results and interpretation of the site and soils investigation need to be submitted with the permit application. A site investigation is needed because it is one of the most critical parts of the project. The investigation evaluates the physical characteristics and, therefore, the adequacy and vulnerability of the soil in a proposed area. This is the only means by which soil substructure can be checked for such problem conditions as the presence of a sand lenses or shallow bedrock. A site evaluation is necessary at proposed manure storage system sites in order to identify site characteristics that may pose a challenge to construction, operation and maintenance of the system, in order to protect ground water. Some designers have proposed that no liner be installed if no soils of rapid permeability are encountered during the preliminary site investigations. However, soil investigations throughout Minnesota have indicated that preliminary soil investigations at a site may not detect all types of soil deposits, when the borings or test holes miss them. This presents a design and cost/benefit challenge to a designer and project proposer. That is, if a designer were to propose that no liner be installed based on preliminary investigations at the site, then the project proposer runs the risk that unexpected site limitations (i.e., the unexpected presence of water-bearing soils in the project area) will be present. This will result in either the determination that now a different liner must be installed or a change in the location of the basin is needed. With this unplanned change comes a corresponding unexpected increase in cost and time for the project, or that no provisions are made to cut off more permeable soils from seepage, thus resulting in potential pollution of ground water.

The required investigation includes, as stated in item A, subitem 1, an analysis of the foundation soils for stability to ensure they are of sufficient strength so that failure of a berm or wall is minimized. Having soils of sufficient strength will minimize the risk of costly engineering modifications or problems during and after construction. A thorough and accurate soils investigation saves money by minimizing soil stability problems and can thereby prevent construction delays. Proper design, materials, construction and maintenance of liquid storage systems are required to prevent failures that may result in flow to surface waters, or seepage to ground water. Improperly constructed and maintained structures have failed, in some cases resulting in catastrophic damage to surface waters, or pollution of ground water. Typical causes of failures of above-ground manure storage structures include inadequate wall or dike strength, damage to dike walls from various causes (see also SONAR under subpart 7, Operation and Maintenance Plan) and use of permeable materials that won't restrict leakage. Below-ground structures have typically caused ground water pollution when manure has seeped out through soil layers of moderate to rapid permeability, either because no liner was installed, the liner was not installed properly to restrict seepage, or damage to the linear occurred.

In Item A, subitems 2 to 6, the agency proposes requirements for soils investigations at the site of a proposed liquid manure storage area.

Subitem 2. In this subitem, the agency specifies the minimum number of soil borings or soil profile records that must be obtained from within the boundaries of the proposed storage area, requiring at least two records for the first half-acre of surface area and at least one additional record for each acre or portion thereof. The provision also requires soil profile records to be obtained in sufficient numbers to represent the range of soil conditions throughout the proposed site. For example a one-acre basin would require that a minimum of three soil profile records be obtained. However, if in this same one-acre basin example, the basin is proposed in an area of shallow soils over bedrock and the depth to bedrock varies considerably in the first three borings or records, the site investigator is required to obtain additional borings until the range of bedrock depth has been delineated. The minimum number of borings is needed so that design engineers obtain sufficient site information not limited to soil type, texture, depth to saturated soils, and depth to bedrock. The number of boring or records is reasonable because the design engineer needs this information to properly design the basin and evaluate the site conditions for conformance to this part. In addition, significant construction delays are often avoided by a proper site and soils investigation. Agency staff has observed several sites where sand lenses and/or a seasonally high water table was present, and that was not identified in a pre-design site investigation. These projects saw significant delays and increased construction costs to address the problems on-site. Additional soils borings would likely have identified the potential for these problems and resulted in the designer being able to prepare for the site conditions and avoid delays. Under the current permitting program, the agency requires this information for all proposed liquid manure storage areas. See Exhibits M-11, M-18 and M-26.

Subitem 3. The agency proposes to require the soil records to be obtained to a depth of at least five feet below the bottom of the proposed liquid manure storage area, except when required deeper in subitem 4. The depth of five feet is needed to evaluate the foundation soils as required in subitem 1 and, for example, to further evaluate the soil conditions for the presence of the water table or saturated soils and to properly design a perimeter drainage tile system as required in subitem 9. This provision is reasonable because, like subitem 2, it minimizes the likelihood of construction or operation related problems if sufficient site information is not obtained. Under the current program and as stated in the agency's guidelines for cohesive soil and concrete-lined manure storage areas, the agency has required design engineers to obtain soils information to this depth and the NRCS required designs to meet this requirement. See Exhibits M-11, M-15 and M-18.

Subitem. 4. The agency proposes in subitem 4 that in areas susceptible to soil collapse or sinkhole formation, soil records be obtained to a depth of at least 10 feet below the bottom of the proposed liquid manure storage area or until bedrock is encountered. The need and reasonableness of this provision are similar to subitem 3, however, this information is also needed to evaluate conformance to subpart 2, item B. Under the current program, the agency has required design engineers to obtain soils information to a depth of at least 10 feet below the bottom of the proposed system and the NRCS required designs in these areas to obtain soils information to a depth of at least ten feet below the bottom of the proposed system. See Exhibits M-11, M-15 and M-18.

Subitem 5. The agency proposes that soil records to identify the soil texture, depth to the regional water table and depth to the seasonally high water table. As mentioned above this information is needed and reasonable to properly design the manure storage area including the perimeter drain tile system, to minimize the likelihood of construction related delays and defects and for conformance to the requirements of this part. Under the current program, the agency has required design engineers to obtain this information and the NRCS required designs to obtain this information. See Exhibits M-11, M-15 and M-18. The agency also provides guidance on recommended soil testing practices and methods prior to construction (Exhibit M-10).

Subitem 6. The proposed language contains the requirement for soil profile information to be obtained by a method that can identify abrupt changes in soil texture and sand lenses of one-half inch or greater. This provision is needed for reasons similar to those stated in this SONAR under subitem 5. Under the current program, the agency has required design engineers to obtain this information. See Exhibits M-11 and M-18. These agency guidance documents further describe several acceptable methods for obtaining this information. They include: rotary augers (continuous sampling is not acceptable); hollow stem augers or Shelby tubes; and backhoes.

Subitem 7. The agency requires, in areas having susceptibility to soil collapse or sinkhole formation, the owner to include a map of the proposed area showing the location of all open and filled sinkholes, depression areas, know caves, resurgent springs, disappearing streams, karst windows and blind valleys within one-half mile of the proposed site. Research has shown that the potential for sinkholes and thus the potential for failure of the structure is more likely to occur in areas with less than approximately 50 feet of soils above the bedrock. This provision allows the agency to obtain the information necessary to make a credible assessment for the concerns outlined in subpart 2, item B. The agency has developed draft guidance to assist in collecting the information under this provision and to further address the issue of reducing the environmental risks associated with constructing liquid manure storage areas in the karst region. See Exhibit M-13. For more discussion on the need and reasonable of this provision, see the discussion under subpart 2, item B.

Subitem 8. In subitem 8, the agency requires an evaluation on whether ground water intrusion will cause construction problems, delays, and damage to the liner or flow into the basin. This provision is needed and reasonable because if ground water flows into the structure it may: expose liner construction problems and significant delays; damage the liner as water seeps into the storage system at levels above the level of manure in the structure during operation; and/or fill the storage system much faster than anticipated due to water intrusion resulting in greater potential for overflow from the storage structure.

Subitem 9. The agency proposes in subitem 9 an evaluation of the need for a drain tile system, where required to control the elevation of the water table in accordance with item J. This requires the plans to included provisions to: (a) lower the elevation of the water table or saturated soils to below the bottom of the liner; (b) locate the tile a horizontal distance of at least two feed outside the footing of a concrete lined structure; (c) install an independent drain tile system for each manure storage structure; and (d) install a tile riser, manhole or other access which allows collection of the water samples for each independent drain tile system. Under (a) the seasonal high water table must be lowered to at least two feet below the bottom of a cohesive soil liner or other non-concrete liner. See Exhibits M-11 and M-18. These provisions are needed and reasonable because groundwater and saturated soils are the most common problem related to construction and proper operation of below ground manure storage structures. Without consideration of the factors and adequate plans to control the potential problems, the risk of structural failure or ongoing excessive seepage to groundwater is significantly increased. Installation of a functional perimeter tile system and monitoring access also allows the agency, delegated county and/or owner to demonstrate whether or not the facility is negatively impacting groundwater. Another factor for owners and designers to consider related to subitems 8 and 9 is the potential for future monitoring or the perimeter tile water. The agency discusses this issue in more detail in a document on Ground Water Monitoring at New Feedlots and Manure Storage Areas in Minnesota. See Exhibit M-12.

Subitem 10. Subitem 10 allows the agency to require additional information on site-specific unique characteristics. This flexibility is needed as new research, laws and practices are developed. The agency can request additional information without having to incur the expense and time of rewriting the rules and requesting the information in specific rule language. This is reasonable because it is in the existing rule and is needed to give the agency flexibility to request additional information as technology changes or as new and/or unique site circumstances arise.

Item B. In item B, the agency requires additional information if the site is located in a drinking water supply management area approved by the Minnesota Department of Health. It is reasonable to require further assessments of the above areas to ensure protection of community public water supplies. This information will allow the agency to make a credible assessment to protect drinking water source protection areas from the threat of storage-related pollution impacts. It also will result in the owner making plans with the knowledge of whether there are possible additional considerations and protection measures needed due to the proposed site location's proximity to a public water supply system. The requested information includes: (1) the location of the animal feedlot and land application sites on a map of the drinking water supply management area; (2) a copy of the vulnerability assessment completed by the water supplier; (3) a description of the vulnerability of the specific manure storage and land application sites as described in the above assessment; and (4) a copy of all parts of the wellhead protection plan or source water protection plan which pertain to animal feedlots and manure management.

Item C. Under item C, the agency proposes to request that the design plans include the estimated storage term based on the volume of manure produced. It further directs that new or modified manure storage structures at feedlots with more than 1,000 animal units be designed to provide for a minimum of 9 months of storage. Due to factors such as weather, soil conditions, crops and the operators' workload, a small window of opportunity exists to spread the manure.

This provision adds needed flexibility to deal with these factors and enhances the opportunity for the manure to be spread at agronomic rates and in an environmentally sound manner. This provision also lowers the risk of basin overflow. Thus, adequate storage capacity must be designed and used.

Item D. The agency proposes in item D that manure storage structures open to precipitation or runoff meet one additional storage volume requirement. This is a needed provision in that it prevents the possibility of accidental manure overflow caused from a precipitation, snowmelt or other runoff event. This provision is reasonable because it provides an adequate storage volume to minimize the land application of manure and waster waters during the winter months and is standard practice as described in NRCS Code 313 Waste Storage Facility (Exhibit M-9) and ASAE Engineering Practice EP393 (Exhibit M-6).

Item E. The agency propose to require that design specifications be brought and discussed at a pre-construction conference. Attendees at the conference must include the design engineer, liner contractors, feedlot owner and the inspector of the facility. During this conference, the construction design and specifications should be discussed, as well as the quality assurance/quality control (QA/QC) plan for the project and each party’s responsibilities. The conference will encourage and facilitate communication among all parties. Everyone involved will have clear expectations of what is required of them. These measures needed and reasonable because they promote quality control and contribute to the production of safe and reliable manure storage structures. Several county feedlot officers require this conference under their program and based on their experience is an essential step to producing a quality structure.

Item F. This item contains proposed specifications to restrict seepage from liquid manure storage structures according to the site restrictions and liner specifications in subparts 2 and 3. This requirement is needed and reasonable in the plans and specifications so that the agency and county have these readily available for initial review to evaluate compliance with this part and for construction inspection purposes.

Item G. The agency proposes to require the location of the borrow site, the soil type and texture (as determined from the soil investigation), volume of liner soil available to ensure that enough volume exists and the testing protocol for soil plasticity index, sieve analysis and optimal moisture for compaction. An MPCA guidance document providing construction specifications, recommended ASTM testing methods and other liner design information is available from the MPCA. See Exhibit M-10. This provision is reasonable because it requires that the designer identify adequate soils for construction of the intended liner. This also minimizes the chances of construction changes on-site, which often result in increased costs for the owner.

Item H. Item H contains the site plan to be included which identifies the location of soil borings relative the location of the proposed manure storage area. This is needed and reasonable because the boring must be taken from the site of storage area to accurately assess the adequacy of the site. Also, the elevations of the boring relative to the planned depth of the structure are critical and needed to maintain the required separation distances to bedrock and seasonally saturated soils.

Item I. Item I contains the requirements for plan details for all liner penetrations according to subpart 3, item C. This is needed and reasonable because the areas where piping or other material pass through the liner are the most likely areas where seepage will occur.

Item J. In item J, the agency proposes that manure storage design plans contain measures for control of the water table or saturated soils at sites where these conditions create ground water forces that may interfere with and damage the liner if they are not controlled. County soil surveys and soil borings are sources of information for identifying the potential of a shallow regional water table. This provision is reasonable because many areas in Minnesota have soils that are seasonally saturated. This shallow, temporary saturation can cause impacts such as liner damage, water intrusion and problems during construction and operation. Therefore, it is reasonable to require that measures/additional design systems be taken in an area of saturated soils. This information is needed to ensure that the perimeter tile will lower the water table or saturated soils, will not serve as a conduit for manure flow, and can be used as a ground water monitoring system in the future if there is reason to suspect seepage problems. These requirements are reasonable because they may save the feedlot owners future expenses, which could result from high water table or the need to install ground water monitoring devices. Additional guidance on controlling the water table or seasonally saturated soils is provided in the agency's guidance documents for concrete and cohesive-soil lined manure storage areas. See Exhibits M-11 and M-18.

Item K. The preparation of, and conformance to, a construction quality assurance/quality control (QA/QC) plan are two of the most important factors in building a high-quality liner system. Construction QA/QC includes holding pre-construction conferences, materials sampling and testing and conducting inspections throughout the construction process. It is important that a knowledgeable design engineer or other qualified consultant prepare the QA/QC plan. Implementation of the QA/QC plan during the construction process will require a qualified soils analyst with experience in cohesive soil liner construction to be on-site during placement of the liner material. Sampling and testing for all manure storage structure projects must be conducted by a qualified technician as well. MPCA guidance documents listed at the beginning of this SONAR section are available from the MPCA for recommendations on ASTM sampling and testing methods for liquid manure storage areas. Item K also requires that the QA/QC plan, including inspection and testing methods and frequencies, be included in the design plans. This requirement has been in practice for almost a decade and is reasonable as review of the plan by MPCA will provide a record on file with MPCA documenting the quality of construction. This is protection for the owner as once again, the owner of the facility is responsible for any environmental effects caused by the structure. Additional guidance on QA/QC plan development is provided in the agency's guidance documents for concrete and cohesive-soil lined manure storage areas. See Exhibits M-11, M-16, M-17 and M-18.

Item L requires that the specifications for liner material protection be submitted to the MPCA. Manure storage liners can be damaged in a number of ways. Damage may occur during the construction phase or during the operational phase. Protection from damage needs to be addressed for liners comprised of earthen, geotextile, reinforced concrete or other combinations.

Damage protection must specifically be planned for the following events: a) drying and cracking during and after liner construction; b) manure agitation and pumping; c) freezing and thawing; d) erosion; and e) other physical damage. The MPCA guidance document recommends for example, that there must be concrete ten feet in any direction from the location where agitation and pumping equipment will be operated (e.g., 20 foot x 20 foot pad on bottom and sidewall) plus protection from equipment traffic if equipment travels down the liner sidewall. See Exhibit M-18.

Item M requires the plans to include discussion and provisions for special site considerations such as building a storage pit under an existing barn, relining an existing unpermitted structure or installing a liner in an existing basin that has severe seepage problems. This is a reasonable provision because each of these example has significant engineering challenges present which may impact the quality of the proposed structure. For example, a pit under an existing barn poses potential problems with excavation of the earth fill, backfilling of vertical concrete walls and access of equipment.

Item N requires that a plan for operation, periodic inspection and maintenance of the storage area be developed and submitted (see also SONAR in subpart 7). All manure storage structures require correct operation along with periodic inspections and maintenance to continue to provide safe and reliable service. Seepage rates will increase if the liner becomes damaged. Damage to the manure storage basin sidewall is particularly a concern with clay liners. Clay liner damage can also occur from careless agitation and pumping of the manure or erosion of sidewalls from wave action and/or precipitation runoff. A list of additional operating and maintenance concerns are identified below. Guidance on reducing risks from damage to Geomembrane and Geosynthetic Clay Liners is available in the guidance documents referenced at the beginning of this section. In general the owner should provide a plan which requires: (a) maintaining a good vegetative cover on the berms and outside slopes of basins; (b) keeping the vegetation mowed to prevent the growth of trees or brush; (c) performing an annual visual inspection of the outside slopes and berm of the basin for signs of erosion, seepage from the structure, or rodent burrows. Burrowing animals should be removed and burrows required with bentonite or compacted soils; (d) maintaining a fence around the perimeter of the structure to prevent children and animals from accidentally falling into the basin; (e) controlling the wastewater level to maintain the minimum design freeboard; and (f) for lagoon systems, a wastewater monitoring protocol should be included for periodic analysis of wastewater for compliance with design loading rates. In addition, the plan should include recommendations for best management practices to prevent lagoon upsets that may result in odor or air emission problems and decreases in lagoon treatment rates.

Subpart 4. Construction and notification requirements. The ultimate quality of the manure storage structure depends greatly on the site-specific conditions and the handling of construction materials whether they be concrete, soils or other materials during construction. Requirements similar to the following have been in place under the current program and have been incorporated into permits issued for construction actives for several years. See Exhibit M-19. Proper placing, consolidating, finishing and curing are essential to produce a manure storage structure, which meets the approved plans and specifications. The potential for ground water degradation from poorly-lined earthen manure storage systems has been demonstrated from monitoring throughout North America. Both the proper design and proper construction are critical to achieve a manure storage structure, which protects water quality.

Item A requires owners to construct manure storage areas (permitted by either the agency or delegated county feedlot officer) in accordance with the design plans and specifications prepared by the design engineer and submitted to the agency or delegated county. This requirement has been in place under the current program and has been incorporated into permits issued for construction actives for several years. See Exhibit M-19. This provision also requires that proposed engineering changes or modifications to the plans and specifications related to the liner specifications, location, depth or separation distance to bedrock must be submitted to the agency or county feedlot officer prior to construction. These provisions are needed and reasonable to maintain the integrity of and relationship between the design and construction processes. It is also reasonable to only require the critical types of design changes to be submitted to the agency. The changes requiring submittals are reasonable because they all relate to the ability of the liner system to be constructed properly and maintain the required seepage rate.

Item B. The agency proposes that the owner must notify the agency or county feedlot officer and the design engineer of intent to construct at least 3 days prior to commencing construction and also specifies the specific information needed in the notification. This requirement has been in place under the current program and has been incorporated into permits issued for construction actives for several years. See Exhibit M-19. The opportunity to inspect or otherwise verify proper procedures and methods is necessary for the agency and counties to achieve regulatory oversight of the liquid manure storage construction. This notification mechanism creates an effective oversight mechanism without providing hardship to the regulated party. It helps support the agency's role as a source of environmental-related information and it provides the agency an avenue to communicate any final concerns it may have. It is reasonable because the owner has the required information readily available and has several options available on the method of notification including letter, phone and facsimile. In addition, the owner typically must inform the design engineer prior to construction or of the date when the pre-construction conference will be held and one call completing each of these tasks is not unreasonable.

Item C. Item C contains the proposed requirements that the owner also needs to notify the agency or delegated county feedlot officer within 3 days following completion of manure storage construction. The provision is needed in order for the agency to fulfill its compliance monitoring duties. This requirement has been in place under the current program and has been incorporated into permits issued for construction actives for several years. See Exhibit M-19. The provision is reasonable in that it is designed to accommodate both the owner and the agency or delegated county. The provision allows the agency the opportunity to inspect the structure, if it determines it is appropriate to do so, prior to the basin becoming filled with the manure. On the other hand, the provision allows the owner to begin use of the basin as soon as technical specifications allow. As with notification of commencement of construction above, the notification information must include the permit number, site owner's name, site location, and the design engineer and contractor working on the project. Acceptable means of notification includes letter, telephone, facsimile or electronic mail.

Item D. In item D, the agency proposes that a final construction report must be sent by the owner or the design engineer to the agency within 60 days of the completion of a new or modified manure storage structure. This requirement has been in place under the current program and has been incorporated into permits issued for construction actives for several years. See Exhibit M-19. The final construction report is a technical document that subjects a construction project to systematic review by an industry professional design engineer. This systematic review is needed and reasonable to verify that the project was built according to specifications and to disclose any deficiencies or problems that may be present. This report helps provide the agency, county, owner and general public with greater assurance that construction of the storage area was completed according to the plans and specifications and with the standards required in this proposed rule.

The terms of the provision were designed to allow use of the basin prior to submittal of a final construction report. This was to done to allow the manure storage facility to be put into use prior to submittal of the final report. This is reasonable as it is often difficult for an engineering firm to development and prepare a report in less than 60 days during the construction season and a delay in use of 60 days may cause hardship to the livestock owner/operator. The ultimate protection of the environment is ensured by making it clear that an unsatisfactory construction report may require the facility owner to remove the manure from the basin and perform necessary corrective action.

Subpart 5. Inspections of liquid manure storage areas. Installation of liners to restrict seepage from liquid storage systems requires considerable expertise, to achieve a seepage rate less than 1/56 inch per day (or 1/560 inch per day as required in subpart 3, item B, subitem 3). Some construction contractors are familiar with materials, technologies, and methods required to achieve this seepage limit, but others are not. Therefore, adequate project oversight by qualified persons is required to ensure proper construction, both to protect ground water (from poor construction) and to ensure that the project owner receives the product designed and bid on. Testing and inspection of materials and professional review of construction documents promote quality construction. Typically, an independent third party such as the designer of structure provides both an opportunity for guidance to contractors unfamiliar with proper construction methods, and protection to the owner, who generally is unfamiliar with the subtleties of construction of these types of structure. This also provides a greater assurance to the public that these structures are being constructed so as to prevent pollution of ground and surface water. Currently there are not enough qualified agency or delegated county inspectors to provide inspections for all the projects proposed.

The owner or operator of an animal feedlot where a concrete manure storage structure will be constructed or installed (and with a capacity of 20,000 gallons or greater) must have inspections completed during the construction process. These inspections are critical to ensure that the structure is being built according to plans, to protect the producers' investment. The inspector must have one or more of the following qualifications:

- Minnesota-registered professional engineer;

- Qualified NRCS staff person; or
- American Concrete Institute (ACI) or Minnesota Department of Transportation (MnDOT), Concrete Field Testing Technician Grade/Level 1 and Concrete Field Inspector Level II certified.

It is reasonable to require a qualified individual to inspect and certify that the critical stages of construction in this item are completed properly because a quality construction process requires knowledge of the potential consequences of construction changes and variances from the approved design. A qualified person is therefore needed, because the inspector must observe and record findings related to conformance to the design plans and specifications and construction standards at the critical stages of construction specified in subitems 1 to 5. These are reasonable requirements for all liquid manure storage project and have been recommended by the agency for several years. See Exhibits M-11 and M-18.

Item C. The agency will under this item require certification by the contractor installing the liner that the manure storage structure was constructed in conformance with the design plans and specifications and construction standards for all stages of construction listed above. This is reasonable because it requires the contractor to be knowledgeable in liquid storage construction, which can differ significantly from earthwork on road projects or concrete work in parking lots, as examples. It also provides the owner with some assurance that the contractor used proper materials and methods and that the owner has received what was bid on and paid for.

Item D. Item D contains the agency's proposal that requires the owner to submit the following information to the design engineer for incorporation into the construction report required in subpart 5, item D:

- Name and qualifications of the inspector;
- Inspector's findings, in accordance with item B; and
- Liner contractor's certification required in item C.

As discussed above, these inspections and certifications which are incorporated into the design report help assure that ground waters are protected by installation of a liner system that meets or exceeds standards. If and when a liquid storage area is suspected of being a contributor to ground water pollution, the construction report can also help identify potential areas of concern or demonstrate that the basin or pit is a very unlikely source of the pollution hazard.

Subpart 6. Operation and Maintenance. It has been observed that physical and biological seals, and even constructed liners may be damaged by any combination of the following factors: freeze/thaw cycles; animal burrows (earthworm, insects, rodents, etc.); drying and cracking of clay liner materials (desiccation); effects of manure agitation and pumping equipment; soil erosion (on sidewalls); roots of vegetation; wave action and hydrostatic pressure from ground water. Damage to either constructed liners or physical or biological seals will typically result in increased seepage, and greater potential from ground water pollution. Therefore, an operation and maintenance plan is warranted to detect and repair any damaged areas of the liner. Designs and specifications should include provisions for liner protection during and after construction, and during routine operations. To help operators do an adequate job in operating and maintaining the structure, an operation and maintenance plan needs to be written, submitted to the agency and complied with. The lack of inspection and and/or structural failure. Earthen basins are vulnerable to erosion, to deep-rooted plant growth and to burrowing animals. Anyone of these conditions may contribute to eventual dike failure. Concrete structures are typically part of total confinement operations and are constructed under the animal livestock holding areas. Lack of inspection may result in overflow. Other problems include the formations of cracks and risk of seepage in the concrete as well as the corrosion and weakening of the steel superstructure used to create a floor above the pits. These problems can be avoided if the feedlot owner conducts regular inspections and provides routine maintenance. Therefore, this provision is reasonable because it provides a pollution prevention benefit and, at the same time, it is not expensive for the producer to implement.

7020.2110 Unpermitted or Non-Certified Liquid Manure Storage Areas

Subpart 1. Schedule for facilities with 1000 animal units or more or that constructed after June 3, 1991. Under subpart 1, owners of unpermitted basins built after June 3, 1991; or owners that have 1000 animal units or more, are required to select one of three options to resolve the potential negative environmental impacts created or maintained by the basin. Item A eliminates potential noncompliance by reconstruction of the unpermitted manure storage area according to part 7020.2100, and item B eliminates the problem by completing closure of the storage area according to part 7020.2025. Item C specifies the third option which requires that the owner locate and submit original design plans for the manure storage area and a construction report stating that the storage area was constructed according to rule and regulations and standard engineering principals and practices, This subpart also requires that the owner complete one of the three options by October 1, 2001.

Items A and B, which require construction of a liner or closure of the manure storage area, are needed and reasonable options to protect the environment from potentially significant damage from an excessively seeping manure storage areas. The reasons are identical to those described in this SONAR under part 7020.2100, which describes the specific water quality and human health hazards related to excessive seepage from liquid manure storage areas.

Item C will likely apply to only a very small number of feedlots, however, it is needed and reasonable because in dealing with unpermitted basins in the past, some feedlots have this information and simply failed to go through the permitting process or complete the process once started. This will apply mainly to feedlots that obtained assistance from the Soil Conservation Service/Natural Resources Conservation Service (NRCS) in design and construction inspection. The requirement that a construction report, or red-lined set of design plans from NRCS, is needed because this is the piece that demonstrates with some confidence that the basin was installed properly. It is reasonable to require that this potential pollution hazard be addressed and eliminated because of the high potential for significant environmental impacts that an excessively seeping basin can create.

The proposed rule allows these owners until October 1, 2001, to complete the liner or close the manure storage area. Given the costs of properly installing a liner, or constructing a completely new system (averaging from about $40,000 to $80,000, with a typical upper limit of about $120,000 for most earthen or synthetic liners), it is reasonable to allow the owner some time to complete the project. The schedule for this group allows over a year from the expected effective date of the rule for the owner to complete one of the three options. This is reasonable time considering that the owner is over 1000 animal units and likely has the resources available to correct the problem or that the problem is significant enough due to the volume of manure that it must be corrected quickly.

The June 3, 1991, criterion is needed because on this date the agency issued a press release (Exhibit M-7) which was widely distributed throughout the state and which identified the requirement for applying for a permit when proposing an earthen manure storage basin and that the plans required a registered engineer's or NRCS staff persons signature. It is therefore justified that the agency consider basins built after this date at any sized facility without proper permitting and design, to address their unpermitted basin on a relatively fast schedule. These owners had a reasonable opportunity to obtain information on the required procedures and therefore should not be given as flexible a schedule as the owners meeting the requirements of subpart 2 or 3.

Subpart 2. Schedule for eligible facilities with fewer than 1000 animal units. This provision requires unpermitted basin owners with fewer than 1000 animal units and that commenced construction of the unpermitted structure before June 3, 1991, to complete one of four options to address the unpermitted structure by October 1, 2003. This provision does not apply to owners meeting the requirements of subpart 3. Similar to the discussion in this SONAR under subpart 1, the October 1, 2003, date for addressing the potential problems is reasonable because it allows adequate time for the owner to plan for and complete any required work and also allows approximately four years to cover the costs associated with correcting any problems with the basin. The four options listed as alternative requirements have been in place under the current program (see guidelines Exhibit T-5) and has been incorporated into permits issued for unpermitted basins for several years (see permit example, Exhibit T-4).

Item A of this subpart provides the same options as items A to C in subpart 1 for the owner to complete. The need and reasonableness of the options is discussed under subpart 1.

Item B of this subpart describes the fourth option to address the unpermitted structure under which the owner must have a design engineer conduct a soils investigation at the site of the structure meeting the requirements of subitems (1) to (6). The soils investigation report by the design engineer must demonstrate compliance with applicable NRCS design and construction standards and that the in-place soils are limiting seepage to the groundwater in accordance with these standards. See Exhibits M-9 and M-15. This option allows the commissioner or county feedlot officer to approve the structure for continued use with little to no remedial work on the storage structure. The key point here is that the soils report must demonstrate that seepage is adequately limited by meeting three key sections of the NRCS Code No. 425 or No. 313 including: (a) sealing/lining waste storage ponds; (b) vertical separation to groundwater; and (c) vertical separation to bedrock. This is reasonable because if it cannot be demonstrated that the basin liner is providing adequate protection against negative environmental impacts, then the structure should not be allowed to maintain potential negative impacts to the environment. It is also reasonable to allow these structures to continue being used if it can be demonstrated that they are not negatively impacting the environment.

The quality and content of soils reports that are submitted under the current unpermitted basin program is that many simply describe the soil profile, with no assessment of the adequacy of the soils to limit seepage. These types of reports place a high degree of administrative burden on regulatory staff who must then attempt to evaluate the site based solely on soil records and incomplete information. Similar to the discussion of other parts of this rule, the MPCA's intent here is to place this responsibility with the owner (to hire a design engineer to complete the report) and allow regulatory staff to focus on more inspections and on reviewing only soils reports from higher risk locations. The process of the owner being responsible for demonstrating that the soils information meets the NRCS standard will reduce the number of reports that regulatory staff must review, because design engineers will not "certify adequacy" at many of the same types of sites that the agency is currently getting soils records for unpermitted basins. Many of these soils reports currently include minimal soils information and little to no assessment of the integrity of the basin and are simply submitted with the thought of "let's see if MPCA thinks this is adequate," without giving any further assessment of the basin. Staff expect that unpermitted basins located in areas of coarse soils, sand lenses and high water tables will not be demonstrated to meet the required standards in most cases. For these reasons the soil investigation requirements of subitems 2 to 6 are needed to allow demonstration of the adequacy of the structure to a high level of confidence. Without this detailed soils information, demonstration of the potential for negative impacts from the structure would be very difficult.

Subpart 3. This subpart only applies to feedlots with fewer than 300 animal units that are under the long-term discharge compliance schedule under part 7020.2003, by being registered and accepting of the conditions under that part. This provision also applies only when reconstruction or closure of the liquid storage area is required. Closure or reconstruction would primarily be required based on the inability of a design engineer to demonstrate compliance with NRCS Practice Codes through a soils investigation. Under item A of this subpart, by October 1, 2003, the owner is required to notify the commissioner or agency of the option, which they intend to follow and complete. This is reasonable because the owner will have roughly three years from the effective date of this rule to determine which of the two options is best suited to their feedlot (reconstruction or closure). This provision does not require the owner to complete actual site work upon the October 1, 2003, deadline. That site work must be completed by October 1, 2009. For example, the owner could fully intend and notify the commissioner that an earthen basin will be closed by October 1, 2009. The owner could then modify this decision, and notify the commissioner, allowing for sufficient time before actual completing the reconstruction prior the October 1, 2009, deadline. This provision does not intend that the owner have the option to conduct a second soils investigation to demonstrate that the basin meets the NRCS standards. This provision is also reasonable because it is consistent with the goals and intent of the discharge standards in part 7020.2003 for these owners which also allows an additional six years or until October 1, 2009, under item B, to complete remedial work. The proposed rule deals with this issue resulting in improving environmental performance and maximizing the decision making flexibility for the owner and giving the owner sufficient time to plan and implement and finance the necessary improvements.

7020.2120 Poultry Barn Floors

The agency has determined that a poultry barn floor liner is needed in a variety of situations in Minnesota due to the potential for groundwater contamination. The potential for groundwater contamination has been evidenced by the following research: North Dakota Department of Health study, "Nitrogen Concentrations Under Turkey Barn Floors" (Exhibit S-2), the University of Delaware studies by Kenneth Lomax, "Nitrogen Barriers for Broiler House Floors" (Exhibit S-3) and "Soil Nitrogen Concentrations Under Broiler Houses" (Exhibit S-1), Investigation report prepared by Tiry Engineering (Exhibit B-3) and by the University of Minnesota report, "A Preliminary Study on Seepage from Deep Bedded and Poultry Litter Systems"(Exhibit B-2). In addition, the agency has recommendations for proper siting, design and construction of poultry barn floors in the guidance document "Technical Guidelines for Poultry Barn Floors." See Exhibit B-1.

A clay liner is expected to be the primary option chosen as a poultry barn floor liner or barrier. The requirements for soil-lined floors are similar to those the agency has required for soil-lined poultry barn floors and include specific soils to be used and specific construction methods to be followed. An example of these types of construction requirements is provided in an interim permit issued for construction of a poultry barn floor. See Exhibit B-4. In spite of the research cited above, several issues are often raised when a soil or clay liner is required in "clay-rich" areas of the state:

> Issue 1: Clay in some areas of Minnesota is as much as several hundred feet thick. Isn't it possible to investigate a facility with existing clay and demonstrate that a clay liner is not needed to protect ground water?
>
> Response: Dr. Daniel's work demonstrates that this is not practicable. In his book titled, " Geotechnical Practice for Waste Disposal", he notes, "It is extremely difficult and expensive to prove that a naturally occurring stratum of soil and or rock uniformly possesses low hydraulic conductivity. For this reason, use of a natural soil liner as the sole means for protecting ground water from contamination is not normally recommended." In addition, sand lenses have been discovered during MPCA inspections in many areas where clay was supposedly very deep and homogeneous. The variability of Minnesota's soils and geology is very great.
>
> Issue 2: Where suitable soils exist at the excavation site, the same soils that were over excavated may be replaced as the liner material. Is this reworking of the soils necessary?
>
> Response: Undisturbed glacial till typically has large numbers of macropores such as fractures, earthworm casts, decayed root channel, etc., that water flows through. Research indicates that macropore flow, not flow through soil clods, is the predominant

mechanism of ground water flow in glacial tills, and for movement from the surface to aquifers. If this weren't true, field tile lines wouldn't function effectively in many soils. A constructed clay soil liner should be a uniform liner of clay without fractures. In order to achieve this uniform liner, the clay is placed in thin (six inch or less) layers at proper clay and moisture content, then compacted until clods are joined together in a layer without cracks through it. These layers or lifts are than laid on top of each other, and joined together through compaction using equipment like a sheepsfoot roller, with teeth long enough to penetrate the lift (to join the top layer to the one below it) and also provided kneading action to join soil clods together. When completed, there should not be channels for water to flow through the liner. The purpose of this construction process is to create a uniform seal where no cracks exist

Issue 3: Natural bulk densities produced from compaction by glaciers are greater than can be achieved using compaction equipment.

Response: Density is not directly related to permeability, but rather is a measurement of weight per unit volume. Proctor density is a measurement of soil pore space and the compaction effort applied to soil. It can be a reflection of permeability, but it is not a direct measurement. Soils can meet construction specifications for proctor density and still be relatively permeable. The fractures in glacial till that have developed over time due to freeze/thaw cycles, shrinking and swelling of the clay, penetration of plant roots, etc., have resulted in the formation of channels that water can flow through. These soils are very dens, and it is true that the densities of these soils may be greater than can b achieved during a clay liner construction. However, the cracks tat are present do no all close completely when the soils become saturated. The purpose of the liner construction is to remove the cracks and disrupt the areas where water can flow easily, even if the soil ends up slightly less dense. Properly constructed clay liners will have a much lower permeability than natural clay soils even if they are not as dense as the soil was before e construction

When assessing the proposed options for construction of poultry barn floors, it is necessary to keep in mind the difference between storing dry manure and liquid manure. Dry manure lacks a hydraulic head which "pushes" the contaminates toward groundwater. Instead, in dry litter systems, the concern is over the soil porosity drawing out the liquid from the litter into the underlying soil layers. This contamination eventually reaches the groundwater. This difference allows us to require a wider variety of options for creating a sufficient liner without compromising environmental protection. The need for greater options than those provided in the agency's guidance was discussed in detail during the FMMAC meetings held from May 1999 to October 1999. See Exhibits B-1 and Exhibit O-4. The specific options resulting, in part from those FMMAC meetings, include:

Subpart. 2. Concrete or asphalt will provide a barrier that will prevent ground water contamination. Cracking in the clay and asphalt will need to be managed. Using concrete or asphalt will result in a durable satisfactory liner. This type of liner option will most likely be used be livestock owners or operators who want a durable floor and who are in area that is lacking in clay suitable to build a clay liner. The required minimum thickness of 3.5 inches is reasonable because forms used for most of these buildings consists of common two-by-fours, which have actual dimensions of 1.5 inches by 3.5 inches.

Subpart. 3. The requirements for constructing a clay lined floor are needed to ensure and adequate liner is being installed that will protect ground water. The 12” clay floor option prevents ground water contamination through a combination of impermeable soils and a porosity differential between the clay and the uncompacted natural soil underneath. The 8” option relies less on the thickness of the impermeable layer and more on the porosity differential between the 8 inches of clay and the required sand or geotextile underlayment. This increase porosity differential further prevents migration of contamination into underlying layers. Either option is sufficient to prevent ground water contamination. With both options it is critical to achieve a sufficient hydraulic conductivity in the clay. This is why the standard proctor specification must be met. In both options it is critical to repair the clay that is damaged that is why the repair requirements have been included. Finally, as shown in the example permit for a soil-lined poultry barn floor. See Exhibit B-4. The agency has required a 12-inch floor under the current program for several years. For these reasons, the provisions for soil-lined floor options are needed and reasonable.

Subpart 4. Construction requirements for polyvinyl chloride (PVC) lined floors. A polyvinyl chloride liner is allowed. Again, this option may be used in areas where clay is not present in sufficient quantities at or near the building site. This option simplifies construction compared to a soil-lined floor and the performance of PVC as a liner is well-proven though its common use in landfill systems throughout the country. A protective layer is needed on top of the PVC liner to protect the liner from damage during cleaning of the barns. This option is reasonable because it provides an protective and cost effective alternative to the concrete or asphalt lined floors where adequate soils are not present.

Subpart. 5. This provision is needed to document the quality of the construction process. This is reasonable because it allows the agency to substantiate that quality construction has been undertaken and for the owner to demonstrate that the facility was built in accordance with these rules.

Subpart 6. This provision contains the agency's proposed requirements that the owner to notify the agency or county feedlot officer of intent to construct at least three days prior to commencing construction and within three days following the completion of construction. This subpart also specifies the specific information needed in the notification. The opportunity to inspect or otherwise verify proper procedures and methods is necessary for the agency and counties to achieve regulatory oversight of the construction. This notification mechanism creates an effective oversight mechanism without providing hardship to the regulated party. It helps support the agency’s role as a source of environmental-related information and it provides the agency an avenue to communicate any final concerns it may have. It is reasonable because the owner has the required information readily available and has several options available on the method of notification including letter, phone and facsimile.

7020.2125 Manure Stockpiling Sites

Subpart 1. Through inspections and enforcement actions, the agency has documented the environmental damage that can result from poorly operated, maintained, and or located stockpiles. Photographs taken of stockpile sites document the runoff and resultant crop kill and gullies that form. See Exhibit S-7. Ponding of leachate occurs around many sites, creating a condition for increased risk of ground water contamination. Photographs in Exhibit S-7, also show evidence of killed vegetation that was killed due to runoff contamination from a stockpile. Other photographs show evidence of manure piled next to drainage ditches, at the outlet of the tile line and of manure runoff entering the tile intake. Letters from county feedlot pollution control officers indicate that they observe runoff in road ditches as well. See Exhibits S-4 and S-5.

Preliminary data indicates that ground water quality beneath open feedlots and manure storage pits is impacted. Additional research suggests that poultry manure has the potential to cause ground water pollution through infiltration into the subsurface soils and runoff contaminated with fecal coliform. Researchers concluded that rainfall on well-structured soil will cause the preferential movement of fecal coliform, and could contribute to fecal coliform concentrations in shallow ground water that exceeds standards for domestic discharges, 200 fecal coliform MPN per 100 milliliter of sample. See Exhibit S-8.

In addition, several studies have demonstrated that manure on bare ground for a long period of time can result in a significant environmental issue. The studies were conducted on soils under poultry barns to measure the nitrogen impact from manure on the soil. Soil nitrogen concentrations under a soil floor increased significantly in the top 30 centimeters of soil during a one-year period. See Exhibit S-3.

Although the agency finds sufficient data to support the need to establish minimum standards for stockpiling manure, it does not believe all stockpiling activities warrant the same standard. The proposed rule has requirements for two types of manure stockpiling – short-term and permanent. Subpart 1 contains the restrictions and requirements for permitting, location, design, construction, operation and maintenance of short-term and permanent stockpiling sites. The intent of this proposed part is to prevent ground and surface water contamination from stockpiles of manure.

The location standards are the same as for other animal feedlot facilities and are found in part 7020.2005. Similarly, the need and reasonableness are found in the discussion for part 7020.2005, which addresses the separation distances for any manure holding facility or operations with the potential to generate manure-contaminated runoff. Location restrictions specific to manure stockpiles are presented and discussed in subpart 2, item C.

Item A. In Item A, the agency proposes the requirement that the location and construction of stockpiles be such that prevent manure-contaminated runoff from the site does not discharge to waters of the state. This item is intended to clarify the agency position that manure or manure-contaminated runoff should not impact surface water.

This requirement is needed due to the enormous oxygen depleting properties of manure, which in the case of hog or cattle manure are 200 times stronger than untreated municipal sewage. See Exhibit S-9. For example, a manure stockpile from a feedlot of 300 animal units has a pollution risk equivalent to that of a municipal plant serving 60,000 people.

Given the significant environmental impact from manure contaminating ground and surface water as discussed in the statement of need in general and above, it is reasonable to regulate the practice of stockpiling manure. Additionally, part 7020.2003 proposes a water quality discharge standard consistent with the federal regulations, 40 CFR 412, and existing Minnesota rules, 7050.0215. The provisions of the water quality standard are discussed in that section of this SONAR relating specifically to part 7020.2003. It is reasonable to provide operators of manure stockpiles a mechanism to avoid the need for a federal or state permit if management design, location and management options will provide the necessary protection for waterbodies.

Thus, the most cost-effective manner to meet the provisions of part 7020.2003 and maintain stockpiles appropriate for a specific animal feedlot operation is to prevent any discharge from the stockpile. The impact of manure-contaminated runoff has been discussed thoroughly in this SONAR. While treatment options for runoff exist, the agency believes that it is more reasonable to clearly define for the feedlot owner that no discharge should occur than to have the feedlot owner run models or continually prove that a small discharge from a current feedlot stockpile will have no impact. Many small operations and the poultry sector utilize scraping techniques and may be exempt from the permit requirements of the federal and state rules. It is, therefore, reasonable that their standards put them outside the need for permitting by allowing a discharge that would require treatment before reaching water bodies.

Item B. Item B requires manure be stockpiled at a three to one horizontal to vertical ratio or have, at a minimum, a 15 percent solids content. Stockpiling manure on bare ground outside of the confines of an earthen or concrete storage structure has many environmental risks, including rapid infiltration to ground water and runoff to surface waters. The impacts of contaminants from manure and manure-contaminated runoff have been thoroughly discussed in the need and reasonableness as a whole earlier in this document. Thus, it is important that stockpiling of manure be accomplished in a manner that does not create or add to the risk of managing manure. Stockpiling of manure is allowed only for solid manure, or manure with no free liquids that could create management problems on the stockpile pad and infiltrate or runoff the pad. Additionally, since the manure on a stockpile will require at least two moves; placement for storage and retrieval land applying the manure, it is must be in a condition to permit easy movement. Land application would occur as soon as the weather and cropping patterns allow. The stockpiling ration and percent solid requirements are intended to ensure that only solid manure is stored in stockpiles and management options are not hampered.

All materials have an angle of repose, the slope held by a material before it will naturally slough off due to gravity forces overpowering the other forces hold the material in place and that they will hold the pile shape. For instance, the ability to pile sand to a certain height on a particular footprint is less than the ability to place a finer soil regime. This angle will vary to some degree based on the soil moisture but typically a general angle of slope exists for most material types. In establishing limits capable of protecting the environment for stockpiling manure, the agency needed to consider such factors as the typical equipment available to most feedlot owners, the amount of manure to be stockpiled, the condition of the stockpiled manure, and the cost of meeting the standard. Consider if the agency limited the slope to a six to one horizontal to vertical ratio as compared to the proposed standard. The six to one pile would be flatter and thus, require a larger pad to hold the same volume of manure than the steeper three to one ration. The additional problems caused by the flat stockpile would include more surface area in contact with precipitation and thus, potentially more difficulty in managing the manure since it will be wetter, less runoff down the outside slope; and the distance a feedlot owner would be placing material after the first levels of manure are in place. On the other hand, if the agency picked a steeper slope, the feedlot owner would need a smaller pad to store the same volume of manure, but the manure may not remain at a stable slope as precipitation starts to be absorbed and increase the moisture content. Thus, the three to one ration provided a reasonable compromise in minimizing construction costs for stockpile pads but did not present operational issues with the height or instability of the pile.

The angle of repose for a particular material is based on a number of factors, one of which is the moisture content. For manure to be stockpiled, the agency selected 15 percent moisture as a minimum standard. The percent moisture was selected because it ensured that the feedlot owner could easily manage the material for placement and retrieval prior to land application; because combined with the slope ratio a protective standard for the stockpile integrity will be achieved; and feedlot owners can easily adapt existing efforts to meet the standards or can appropriately plan for the manure management system in a new facility. A higher moisture content would create management difficulties in moving the manure and in stabilizing the stockpile. The agency believes that the percent moisture and the slope are reasonable standards because they allow the feedlot owner to maximize the use of existing systems while minimizing costs associated with stockpile pads.

Item C. Item C prohibits the use of rock quarries, gravel or sand pits and any mining excavation sites for storage of manure. Soils in these areas have intentionally been removed. In many situations, very little distance between the base of the excavation and the ground water table may exist. Thus, manure placed in an excavated pit would have a greater potential to pollute ground water. These areas would have no soil to allow the natural attenuation or reduction of pollutants to occur before manure contaminants would enter ground water. In other situations, the quarry may no longer be used because ground water was hit and there is no separation from ground water. In a third scenario, mining has stopped because soils with low permeability are at the surface and precipitation and run-on are forming ponding water. In the last two scenarios, a feedlot owner using these areas would be in direct violation of Minn. R. ch. 7020. Based on the environmental risk of using mined areas for manure stockpiling, the agency believes it is reasonable to prohibit the storage of manure in these areas. Additionally, these areas are often not conducive to moving the manure back out for land application.

For this reason, stockpiles are prohibited from being placed on fractured bedrock as well. The probability of nitrates, phosphorus and other nutrients entering ground water is greater in the excavated areas. Since stockpiles in these areas have a higher risk of contaminating ground water, thus, it is reasonable to prohibit stockpiles in these areas.

Item D. In item D, the agency proposes to limit the size of short-term stockpiles. The limit is highly linked to the agronomic needs of the crop on the tract of land not to exceed 320 acres. The volume of manure permitted on a short-term stockpile is based on the agronomic needs of the crop raised on the specific track of land on which the manure will be applied. In the item, the agency further proposes that the agronomic needs of the crop comply with the application rates in the land application section of the proposed part 7020.2225.

The agency has observed stockpiles up to one-quarter mile long. Such stockpiles without proper controls present a risk to ground water through infiltration and surface water from contaminated runoff. Earlier proposals suggested that due to the need prevent nuisance conditions and runoff from large quantities of stockpiled manure, the stockpile size would not exceed 10,000 square feet. A recent visit by agency staff to a farm with a turkey manure stockpile illustrates that this square footage limitation was impractical. The amount of manure would have required multiple stockpiles on the land parcel if the stockpile were limited to 10,000 square feet. Manure is stockpiled on land to be used for its fertilizer value and large quantities could be stockpiled in order to apply the manure at agronomic rates. For an average tract of land of 320 acres (one-half section), the stockpile would need to be formed at a height of 15 to 20 feet if the base or footprint was limited to 100 feet by 100 feet. Only feedlot owners that owned payloaders or who rented a payloader could achieve that height. The cost of renting a payloader could exceed $300 per day. Feedlot owners without access to this equipment would need to form several shorter stockpiles, which would create management difficulties and potentially create more runoff. For these reasons, the agency elected not to establish a square foot limit.

Since the purpose of stockpiling manure was for use as a nutrient source for croplands, the agency elected to pursue a requirement based on the amount of manure to properly land apply the manure on a tract of land. The volume of manure permitted for short-term stockpiles was discussed and consensus reached at the FMMAC meetings in 1999. The agency believes the final standard is reasonable because it allows the feedlot owner stockpile manure near the sites it will be land applied but does not increase the environmental risk.

Subpart 2. Subpart 2 contains the additional requirements proposed by the agency for short-term stockpiling. The requirements for this subpart require compliance by October 1, 2001, (approximately one year after the effective date of this part) allowing feedlot owners time to plan for any operational changes that the proposed rule would require. The agency believes a specific date is required to place feedlot owners on notice that the standards will be effective and the agency will have specific expectations when agency staff or CFOs conduct an inspection. The agency further believes that the proposed date is reasonable in that it allows the feedlot owner to consider possible stockpile locations during the winter season as other plans for cropping specifics are prepared. No capital outlay will be required and thus, establishing a longer time frame for compliance is unnecessary.

Item A. The agency proposes, in item A, that the manure in the short-term stockpile be removed from the stockpile site within 180 calendar days from the initial use of the stockpile and land applied in accordance with the proposed feedlot land application requirements, part 7020.2225. Item A does provide for the feedlot owner to extend this time frame provided the conditions of subitems 1 and 2 are met. Subitem 1 provides for a maximum time frame of one year from the date when the stockpile was initially established for the feedlot owner to land apply the stockpiled manure. In subitem 2, the agency proposes that the feedlot owner submit an extension notice to the commissioner or the delegated county. The notification form will be provided by the commissioner and on it must be a description the soil or weather conditions that prevented the removal or land application of the manure and the location of each short-term stockpile that will remain after the 180 days.

Early in the development of the proposed rules, the agency proposed three categories of stockpiling: short-term, less than 60 days; long-term, 12 months or less; and permanent stockpiling, longer than 12 months. Although poultry and turkey producers liked the earlier draft, especially the ability to store manure on stockpile sites up to a year with few restrictions, agency staff, county feedlot officers and environmentalists had concerns had concerns. Particularly, the categories of short-term and long-term stockpiling seemed arbitrary and would be difficult to verify. For example, a manure stockpile, under the proposal, would change from a short-term to a long-term stockpile after the passage from 60 to 61 days. Monitoring for compliance is difficult if not impossible for short or long term piles through a visual inspection of a large manure stockpile. Although subpart 3 of this part requires that records be kept of when the stockpiles were established, an inspector driving by, or neighbor, would not have this information and only with a complete audit of land application dates, estimated manure generation, etc. could verification be complete. The agency and delegated counties needed a method to visually determine the difference in stockpiles. Also, some producers argued that permits for each stockpile would be administratively burdensome for agency, delegated counties and producers without any more assurance on the length of time manure had been stockpiled. The agency agreed and sought solutions that would not require permits for stockpiles only. However, the agency believed it important to develop a system that was not administratively burdensome, was easy to field verify and limited the time a stockpile can remain on bare soil to protect the environment.

At least three studies have been conducted that demonstrate that manure placed directly on bare ground for a long period of time can result in a significant environmental issue. The studies were conducted on soils under poultry barns to measure the nitrogen impact from manure on the soil. Since the manure in the poultry barn is not exposed to precipitation (and would not have the higher water content resulting in greater leaching of nitrogen into the soil), it is reasonable to believe that an open stockpile would have a greater impact on the soil under the stockpile than was measured under the barns in the studies. See Exhibits S-1, S-2 and S-3.

An existing poultry barn with a new (barrier) floor installed was compared to a new poultry barn with no floor over a period of approximately one year. The study concluded that “Soil nitrogen concentrations beneath the barrier floor of a new house did not increase while the concentrations under a typical soil floor increased significantly in the top 30 centimeters of soil beneath the litter during the project period". See Exhibit S-3. Therefore, the agency believes that the duration that manure can be placed on bare ground should be limited.

In addition to short and long-term stockpiles being difficult to monitor for compliance, poultry and turkey producers and other producers would not have really benefited from a 60-day stockpile category as they argued that two "windows of opportunity" to land apply the manure exist. The two opportunities were each five to six months apart, April through May and mid-October through mid-November. See Exhibit S-6. Thus, their schedule, as described, did not lend itself to the previous short-term limit but does fit in with the current six-month short-term limit. The agency believes that the 180-day time frame for a short-term stockpile is reasonable because allows sufficient time for the accumulation of manure over the winter months, a time land application is discouraged, and over the cropping season when again access to land application sites would be limited.

Complaints of large manure stockpiles being observed in the same place year after year over sandy soils and runoff from stockpiles into tile intakes and abandoned wells have been received by the agency. The following pollutants may be contained in manure and associated bedding materials and could be transported by runoff water and process wastewater from confined animal facilities:

- Oxygen-demanding substances;
- Nitrogen, phosphorus, and many other major and minor nutrients or other deleterious materials;
- Organic solids;
- Salts;
- Bacteria, viruses, and other micro-organisms; and
- Sediments.

Fish kills may result from runoff, wastewater, or manure entering surface waters, due to ammonia or dissolved oxygen depletion. The decomposition of organic materials can deplete dissolved oxygen supplies in water, resulting in anoxic or anaerobic conditions. Methane, amines, and sulfide are produced in anaerobic waters, causing the water to acquire an unpleasant odor, taste, and appearance. Such waters can be unsuitable for drinking, fishing, and other recreational uses.

The high nutrient and salt content of manure and runoff from manure-covered areas, contamination of ground water can be a problem if storage structures are not built to minimize seepage. Animal diseases can be transmitted to humans through contact with animal feces. Runoff from fields receiving manure will contain extremely high numbers of bacteria if the manure has not been incorporated or the bacteria have not been subject to stress. A more detailed discussion on the impacts of pollutants found in manure and manure-contaminated runoff is found under the Section III, Need for the Rules, of this SONAR.

According to the U.S. Department of Agriculture and EPA, "Dry manure, such as that produced in certain poultry and beef operations, should be stored in production buildings or storage facilities or otherwise stored in such a way so as to prevent polluted runoff." They go on to state that "Poultry operations that remove waste from pens and stack it in areas exposed to rainfall or adjacent to a water course may be considered to have established a crude liquid manure system." See Exhibit G-2.

Based on the above evidence that the duration manure of piled on bare ground should be limited and potential problems with timing land application, it is reasonable to limit the duration of a short-term stockpile site to 180 days and to allow an extension only if weather conditions prevent timely application.

Subitem 1. Subitem 1 contains the agency's proposed limitation on the maximum time a manure stockpile may exist under the category of short-term. The proposed subitem indicates that land application of the manure must occur within one year after the stockpile was initially established. A maximum time frame is needed to ensure that extensions are not regularly granted through the notification process of subitem 2 with no land application ultimately occurring. The agency routinely receives complaints that a stockpile has existed in a particular location for more than one year with no ability to substantiate the time frame. A maximum time frame of one year is reasonable because the short-term stockpile is usually sited near the field where land application will occur and thus, given the windows of opportunity, an equivalent of six months of the year would be available for land application and the weather and soil conditions should be acceptable at some period during that time.

Subitem 2. In subitem 2, the agency proposes that the feedlot owner provide the notice to extend beyond the time frame associated with short-term stockpiling before the 180-day time frame expires on a form provided by the agency. The commissioner or the CFO would need to be notified. Notification is required because these facilities will typically change locations regularly and without some minimal tracking system, the agency or delegated county would be unable to respond to complaints without extensive field verification and thus, be unable to deal with more appropriate issues. The provision is reasonable as minimal effort is required of the feedlot owner and no extra or special approvals must be obtained. The notification can be avoided with careful planning and management.

Units a and b. Subitem 2 also contains the agency's proposed conditions under which the storage duration of a short-term stockpile may occur without further design and construction restrictions being applied by the agency or delegated county. Unit a indicates that the feedlot owner must indicate the weather and soils conditions that prevented land application within the 180-day time frame. Unit b contains the requirement that the feedlot owner provide the location of the stockpile. The provisions in units a and b are needed to allow the agency or delegated county to track those stockpiles that have extended beyond the 180-day time frame through no fault of the feedlot owner. This information allows the agency or delegated county to verify the location and respond to complaints timely. The information requested on the notification is minimal in nature and is known by the feedlot owner. It is reasonable to track extended short-term stockpiles to ensure that they do not become permanent stockpiles without the protection methods incorporated into those standards.

Subpart 2, item B. The agency proposes in item B that a vegetative cover be established on the site after the manure is removed and remain for at least one full growing season before the site can be reused as a short-term stockpile site. An exception is proposed for sites located within the confines of a feedlot containing less than 100 animal units of hooved animals. Feedlot owners with cows confined to lots do not need to re-establish vegetation after the manure is removed because the soil under the feedlot becomes compacted by the animals' hooves, forming a seal against infiltration. See Exhibits S-12 and S-13. To meet the requirement for vegetative cover, the feedlot would need to remain vacant during the calendar year preceding or following the calendar year in which the site is used. It is unreasonable to require a feedlot owner not to utilize the open lot for two out every three years. The feedlot owner would incur unnecessary costs in designing and maintaining sufficient areas to confine the animals under such a scenario.

The selection of 100 animal units was made based on the agency's knowledge on size of existing feedlots and planned feedlots for hooved animals. The feedlot being used to confine a herd equivalent of 100 animal units is typically only a few acres. The amount of area subject to erosion and sediment runoff would be limited by site controls or location of the site. The capitol outlay needed to control surface water movement through the small feedlot is minimal and can be accomplished with inexpensive diversion berms. However, once the feedlot is large enough to confine a herd equivalent to more than 100 animal units the amount of non-vegetated ground expands considerable and the potential for erosion and sediment runoff grows. The feedlot owner is now managing an area that will require surface water controls that may need to divert water from a mini-watershed. The agency believes that management of the larger confined feedlots puts the environment at unnecessary risk to runoff and a better management system is available to the feedlot owner. The agency believes the use of 100 animal units is reasonable as it accounts for most existing small operations and still allows controls to be reasonably developed for the site without significant cost to the feedlot owner.

The purpose of establishing vegetation on soil is to remove buildup of nutrients (i.e., nitrates and phosphorus) that have occurred. High nutrient buildup of soils is common where land areas have been used as feedlot sites or manure stockpile sites. Nutrient buildup in the soil is generally a precondition for the potential pollution of ground water. Therefore, it is reasonable to require that owners re-vegetate land following its use as a stockpile site. The site cannot be used for a year to allow for one full growing season and the resultant uptake of nutrients by the vegetation.

Item C. Item C, as proposed, contains the minimum setbacks specifically to short-term stockpiles of manure. Because these stockpiles will be utilized on the fields that will ultimately received the manure, it is important that the stockpile be established in low risk areas for ground water and surface water impacts. The agency believes it is reasonable to provide a set of performance standards for locating the stockpiles as they will not receive an individual site review through a permitting process, which would evaluate the location for potential risks. By codifying the agency's expectations relative to locating stockpiles, feedlot owners have the knowledge to establish manure stockpiles without creating unnecessary environmental risks. The agency believes it is reasonable to provide the feedlot owner the location requirements considered acceptable in a likely portion of the proposed rules so that the feedlot owners may plan accordingly and not be required to move a stockpile prematurely because it is located in an area deemed unacceptable based on environmental risk. Additionally, it is reasonable to let other interested parties know the agency's expectations so that they can respond to risks they feel are relative to the location standards. Since short-term stockpiles are not required to be permitted the rule process is the only opportunity for public input into these standards.

Subitem 1. In subitem 1, the agency proposes to establish a setback of 300 feet of flow distance and at least 50 feet horizontal distance, to waters of the state, sinkholes, rock outcropping, open tile intakes, and any uncultivated wetlands that are not seeded to annual farm crops or crop rotations involving pasture grasses or legumes. Two-thirds of Minnesotans drink the ground water. For purposes of protecting public health it is critical that runoff from manure, which is high in nitrates, be prevented from discharging to ground water. Protection of this important resource is essential. Subitem 1 establishes the setback distances needed to encourage manure-contaminated runoff to infiltrate into subsurface soils before reaching the geologic formation, landscape conditions, and manmade structures that would act as direct conduits to ground water.

The setback distances were developed based on the typical topsoil for Minnesota and the infiltration rate of water. It is expected that the setbacks provide sufficient assurance that infiltration will occur and direct discharges to the above natural and manmade conveyances to ground water will be avoided. The proposed setbacks are reasonable because they protect the ground water resources of Minnesota and yet allow the producer the flexibility to place the short-term stockpile anywhere on a field where these setbacks are achieved. The provisions are less intrusive to the producer than a technical standard with pre-established setbacks from roadways, driveways, ditches, etc. that would eliminated much of the field and thus, potentially result in management difficulties for the producer in placing the stockpile as near the land application site as possible.

Subitem 2. The agency proposes to establish in subitem 2 a setback of 300-feet flow distance to any road ditch that flows to the features identified in subitem 1 or 50 feet of any road ditch where subitem 1 does not apply. Road ditches typically outlet at some point to a surface waterbody. It is important that manure-contaminated runoff or manure not enter these drainage devices. Again, the setbacks were establish to encourage infiltration into the subsurface soils prior to reaching the ditch but are not so intrusive that the only location available to site a stockpile is in the center of a field. It is important to retain flexibility for the producer in locating the stockpile while ensuring sufficient protection of surface waterbodies from manure-contaminated runoff. The agency believes that it has found a reasonable balance between the flexibility and protective standard remembering that no regulatory review will occur at these sites prior to their establishment.

Subitem 3. Under subitem 3, the agency proposes to establish a setback distance for short-term stockpiles from drinking water wells. The setback is proposed to address private water supply wells and not community wells. Subitem 3 defines the restriction to be 100 feet from any private water supply or abandoned well and 200 feet from any private well with less than 50 feet of watertight casing and that is not cased through a confining layer at least 10 feet thick.

Community wells are not addressed in this subitem because an overall location restriction exists in part 7020.2005 and it is unlikely that the field designated for land application of manure from a short-term stockpile would be near the confines of a community well system. The producer will not be traveling significant distances to develop the stockpile due to the operational difficulties it presents in moving the manure.

Pathogens, such as Cryptosporidium, have been linked to impairments in drinking water supplies and threats to human health. Nitrogen, in the form of nitrate, can contaminate drinking water supplies drawn from ground water, and can be deadly to infants. For health reasons, the nitrate standard in drinking water is 10 milligrams per liter. See Minn. R. pt. 4717.7100 to pt. 4717.8100. Thus, it is necessary to require that stockpiles be located away from wells that have not been constructed in such a manner as to prevent the direct migration of runoff into the ground water.

The setback distances and well construction criteria are based on the minimum standards required to protect the ground water from receiving direct manure-contaminated runoff. Wells, not constructed in the manner described in subitem 3, are most vulnerable to direct runoff and are typically associated with older farmsteads. It is important that these vulnerable wells not risk and ultimately those using the well for drinking water at risk from manure-contaminated runoff. The setbacks encourage infiltration prior to reaching the well and yet are not so exclusive that the producer could not locate a short-term stockpile near the farmstead to permit the management of manure and an efficient manner. Other provisions in the proposed rules do not require that the short-term stockpile to be located at the field designated for land application. It would be unreasonable to establish setbacks that would prohibit the scrape and stack operations associated with small operations. The agency believes that it has proposed a standard that reasonably balances the need for protecting ground water and allowing the feedlot owner flexibility in managing the feedlot.

Subitem 4. In subitem 4, the agency proposes to establish a setback of 100 feet from field drain tile that are three feet or less from the soil surface. Because many short-term stockpiles will be established near the field that will receive the manure, it is important to consider all conditions that could serve as direct conduits to surface water or ground water. One such hazard encounter in many fields is drain tile used to control soil moisture for cropping purposes. When the tile inlet is at ground surface or near the surface, manure-contaminated runoff would be drawn directly into the tile. At this point, the tile would become a conduit of manure-contaminated runoff to the surface waterbody. This places the surface water at risk for contamination. Thus, a setback of some distance is needed.

The setback is intended to allow sufficient time for runoff to infiltrate into the subsurface soil before reaching the tile inlet. The agency proposes that 100 feet is an appropriate setback. Since the feedlot owner will be managing the manure stockpile to minimize runoff, the purpose of the setback is to gain some time for natural protection systems to occur before the tile inlet is reached. The 100-foot setback allows for the minimal runoff that may occur from a short-term stockpile to infiltrate into the subsurface soils. A setback greater than 100 feet removes an unacceptable amount of cropland from usage. Likely this land would be grassed and thus, have little market value as an income source. A setback less than 100 feet would provide insufficient time for the runoff to infiltrate and be treated through the soils natural processes. The proposed setback would not be imposed on drain tile inlets deeper than three feet because studies have shown that most bacteria and nitrates are reduced in risk within three feet of the sources. This treatment standard is consistent with the agency's approach to managing individual sewage treatment systems, Minn. R. ch. 7080. The feedlot owner has reasonable alternatives to the setback distance in that the tile inlet only need be covered with more soil. The additional soil can be shaped and sloped to direct runoff away from the inlet. The agency believes that the proposed setback is a reasonable standard that provides protection to water resources while not removing land from production.

Item D. In item D, the agency proposes that the feedlot owner maintain a two-foot separation distance between the base of the stockpile and the seasonal high water table or saturated soils. Information on saturated soils can be determined using the USDA/NRCS Soil Manual or a site-specific soils investigation. See Exhibit S-18. The agency believes it is necessary to maintain a minimum separation between the base of the stockpile and the ground water. As previously discussed the potential for contaminant to reach surface water or ground water places these water resources at risk. Additionally, it was explained that short-term stockpiles are not reviewed prior to establishment and locational standards are important to protect environmentally-sensitive or at risk resources. Near surface ground water is a condition that will place the drinking water or nearby surface waterbody at risk for contamination. It is important to minimize this risk.

Under the proposal, stockpiles are allowed to sit on bare soil or minimally-vegetated soil that will be exposed to precipitation for up to six months. A stockpile of manure will release liquids particularly after a precipitation event. The agency believes that a two-foot separation distance to the seasonal high water table or saturated soils when considered with the other setbacks already discussed ample protection to the ground water will be provided. The seasonal high water table does not mean that ground water exists to that level throughout the year. Likely, the seasonal high water table is associated with the spring snow melt and spring rains, or other conditions where precipitation occurs over an extended period of time. For these reasons, the agency does not feel that the entire minimum protection distance be required as was in subitem 3. The agency believes that it is reasonable to ensure that some protection exists by way of the two-foot separation but that it is unreasonable to require a short-term stockpile to meet the three-foot minimum discussed in subitem 3, when the high water mark is also temporary.

Item E. The agency proposes in item E to prohibit the establishment of short-term stockpiles under specific site conditions. The agency finds that particular site conditions do exist that provide no natural protection against contaminants associated with manure. Therefore, it is important that these locations not be considered as potential stockpile sites. It is necessary to define these conditions in rule to provide the standard by which a stockpile will be judged. Establishment of the prohibited locations in rule alerts the feedlot owner on conditions that would place nearby water resources at risk, particularly when no special design or construction requirements are placed on short-term stockpiles. Subitems 1 to 3 contain the proposed prohibitions.

Subitem 1. The agency proposes to prohibit the establishment of a manure short-term stockpile on land with slopes greater than six percent. Steeper slopes in many parts of the state are associated with coarser soil particles and could result in rapid infiltration. Secondly, slopes greater than six percent encourage the flow direction across the site soils down the hill not into the site soils. Again, this infiltration in coarse soils places ground water resources at risk for contamination and the runoff jeopardizes nearby surface waters. The agency believes the slope is reasonable because it is a well-used standard for controlling of runoff including Minn. R. ch. 7041, sewage sludge land application. The six percent slope allows for land application of manure without requiring the need for immediate incorporation as the risk for runoff is controlled prior to the natural breakdown of the manure occurring. It is reasonable to establish for manure a prohibition consistent with other agency programs governing land application of materials.

Subitem 2. In subitem 2, the agency proposes to prohibit the establishment of short-term stockpiles on land with slopes between two and six percent, except where clean water diversions and erosion control structures are installed. As discussed in subitem 1, it is necessary to restrict the degree of slope (increased slope equals increased runoff due to gravity) where stockpiles may be established. Additionally, the agency must considered surface water run-on to the stockpile increasing the likelihood of manure-contaminated runoff. The agency does find it reasonable to allow the establishment of stockpiles where the producer has already taken precautions to control surface water flow and erosion. Clean water diversions and erosion control structures are not only intended to keep soils on the land but keep soil and runoff from reaching surface water. Thus, protection systems exist and should be accounted for in the siting process.

Subitem 3. The agency finds it particularly necessary to control risks to ground water through rapid infiltration of manure-contaminated liquids through coarse soils on the site. Subitem 3 contains the agency's proposal to prohibit short-term stockpiles on sites where the soil texture is coarser than a sandy-loam to a depth of five feet. These coarse soils not only allow liquids to be quickly move through them but have the least attenuative properties regarding contaminant protection. These liquids would be a small amount of free moisture in the manure, precipitation that falls on the manure and runs off and the precipitation that soaks into the manure stockpile and is then released if the saturation point is reached. Soil type, again can be identified using the information available in the USDA/NRCS Soil Manual or a site specific soils investigation. It is reasonable to prohibit the location of stockpiles in locations with coarse soils because if a field were found to have this material throughout a number of sensitive conditions may exist relative to the proximity to ground water. Typically fields would not have coarse soil conditions across the entire site. Rather, it is reasonable to expect that on some portion of the site will be found acceptable. The agency expects this provision to impact only specialized incidents where a field may sit on a potential gravel resources or an old river bed.

Subpart 3. Subpart 3 contains recordkeeping requirements for feedlot owners utilizing short-term stockpiles. The records must be kept by the feedlot owner producing the manure for three years for all short-term stockpiles. The proposed requirements do not require that these records be submitted to the agency or delegated county. The records are only submitted should the agency or delegated county request. Records are needed and serve a variety of purposes outside the agency's or delegated county's responsibilities. Most importantly the information retained by the feedlot owner is useful in maintaining a proper nutrient balance on cropland, understanding how the manure is utilized, and finally building confidence with neighbors that the manure is being managed responsibly.

For example, the size of a stockpile is limited to the agronomic needs of a crop on a tract of land not to exceed 320 acres. If a neighbor or inspector questioned the stockpile's size, the animal feedlot owner would have the documentation to justify the amount of material stored and how it was used in the past. The inspector will be able in reviewing the data correlate application rates and if, an adjustment is needed to the stockpile. A second example of when records might be requested relates to compliance determinations with regard to location of the stockpile to sensitive and prohibited areas outlined in subpart 2. It is reasonable that minimal records that provide valuable information to the producer be kept for planning and response needs. Again, given that the records are needed to determine compliance and the proposed requirements are one of the least intrusive options for demonstrating compliance, it is reasonable to require these records. A minimum of three years is the amount of time agency rules in other programs require for keeping records available and was selected for consistency.

Items A through E contain the specific requirements that the owner must track for the purposes of this subpart. It is necessary to provide the minimum information the agency expects on a report. Since the report will be used to help verify operations at the site, it is important that the owner understand what is needed. The proposed reporting requirements are:

- Location of the stockpile;
- Date on which each stockpile was established;
- Volume of manure stockpiled;
- Nutrient analysis of the manure; and
- Date(s) the stockpiled manure was land applied.

As discussed above, none of the above provisions require the owner to conduct extensive testing; to hire an outside consultant for completion; or to seek out information not available through normal operations under a manure management plan needed for part 7020.2225, land application. The information will exist and will not add additional costs to the owner. Based on the discussion above concerning the value and limited cost of tracking items A to E, it is reasonable to establish in rule the information an inspector would expect to find.

Subpart 4. Subpart 4 lists the additional requirements the agency is proposing for permanent stockpile sites. Permanent stockpile sites are different from short-term sites in that manure will be on the same site for longer than 180 days. Therefore, a facility that stockpiles manure exposes the manure to increased snowmelt and rainfall, logically generating more runoff the longer it is stockpiled. Additionally, because the stockpile is a long-term commitment for manure management, the risk for contaminants seeping into subsurface soils will increase as essentially manure will be on the stockpile pad at all times. For these reasons, it is necessary that the stockpile pad be constructed with a liner and runoff containment system. Owners have until October 1, 2001, to comply with the permanent stockpile requirements in items A to D. In addition, the owner must install a liquid manure storage area to collect and contain manure-contaminated runoff, if necessary to comply with the discharge standard of part 7020.2003.

Item A. In this item, the agency proposes that permit applications be submitted as required under part 7020.0405, subp. 1. Since the establishment of a permanent stockpile requires the construction of a lined pad and runoff control system, it is necessary to look at a more detailed review occur prior to construction. Part 7020.0405 contains permit requirements based on the number of animal units producing manure for the stockpile and other risks associated with the type of facility under consideration. It is reasonable to consider additional review and inspection for permanent stockpiles because the long-term stockpiling of manure increases the risk that the contaminants contained in manure could infiltrate to ground water or runoff to surface water and present the environmental and human health impacts discussed in the need portion of this SONAR.

Item B, subitem 1. The agency proposes in this subitem the requirements for the liner at the stockpile site. Subitem 1 establishes that the liner must be at least two-feet thick and constructed of soils with a hydraulic conductivity of 1×10^{-7} centimeters per second or less after construction. It is necessary that the requirement for the design and construction of the required liner be provided in rule. This proposed standard is an existing regulatory standard for solid waste storage, solid or food waste compost sites, domestic sewage and industrial waste facilities, and is proposed for the minimum standard to be used in constructing liquid manure storage areas, part 7020.2100. Permanent stockpiles are defined as a permanent form of manure storage. Thus, they are comparable to below-ground earthen or concrete manure storage structures. It is reasonable to require a pad or liner be designed and constructed to prevent the infiltration of contaminated liquids into ground water. The basis for the hydraulic conductivity is detailed in the reasonableness for part 7020.2100. It is reasonable that since the liquid manure storage areas and permanent stockpiles are managing the same material the minimum standards be equivalent.

Subitem 2. In this subitem, the agency proposes that the stockpile pad may be constructed of materials other than soil if the material will have a hydraulic conductivity less than 1×10^{-7} centimeters per second. It is necessary to allow for the use of materials other than soil provided the performance standard is met. If soils with a low hydraulic conductivity are not available near the intended location of the stockpile pad costs to construct the pad can escalate rapidly. Once the transport of soil exceeds much more than 15 miles the cost to transport and place will nearly double or triple. Since the cost of material is the largest expense in designing and constructing a stockpile pad, it is reasonable that the agency provide for the use of alternatives meeting the performance standard and thus, allow the feedlot owner the flexibility to make a business decision on the type of material to use. Additionally, the feedlot owner may prefer to use a different material because of operational ease. For instance, concrete is often easier to maintain and work on than a soil liner. The initial cost of construction for concrete could easily be offset by the operational savings on maintaining the soil liner after the placement and removal of manure several times. The agency is concerned with environmental protection and not the business decision relative to the type of material used.

Item C. Item C contains the agency proposed requirements relative to protecting the stockpile from surface water run-on. The requirements state that the site must be constructed using a diversion structure, elevated platform construction, or other devices to prevent surface waters from entering and passing through the stockpile site (run-on). Furthermore, where up gradient slopes exceed two percent, clean water diversions of sufficient height to prevent run-on must surround at least three sides of the permanent stockpile site. These requirements are needed and reasonable to prevent storm water and snowmelt from infiltrating manure stockpiles and carrying away the leachate off the pad into surrounding soils and eventually ground water. Diversion must be of sufficient height to prevent outside water from passing over the diversion structures during snowmelt or rainfall events (less than the 25-year, 24-hour storm event). These provisions are consistent with the protection standards used in locating a facility and it is reasonable that if contaminated runoff must be prevented from moving to surface water the management of runoff generation also occur. Thus, it is reasonable to utilize proper construction techniques to keep surface water away from the stockpile.

Item D. Item D requires that a permanent stockpile be operated and maintained to protect the integrity and structural reliability of the structure. The pad will be subject to routine scraping and wear and tear from heavy equipment. Properly constructed basins and liners do little good if damaged. Additionally, the construction of the stockpile pad is not small and this investment to protect the environment must be part of the normal animal feedlot operations. Therefore, it is reasonable to require that the integrity of the system be maintained. While the agency proposes a protection standard, it does not establish an inspection schedule, testing requirements or similar means to determining the liner integrity, but rather allows the feedlot owner to make such decisions through the material used to construct the liner or as needed, repair to the soil liner through re-construction methods including compacting and resurfacing.

Item E. Item E contains the standard for the owner to notify the commissioner or CFO of intent to construct at least three days before beginning construction. After completion of construction, the owner must also notify the commissioner or county feedlot officer of its completion.

Subitems 1 to 4. The agency proposes that notification be completed by letter, telephone or facsimile. Subitems 1 to 4 establish the information to be provided in the notice. This information must include the permit number, if applicable; the name of facility, if different than the owner; the site location and name of the contractor responsible for installing the liner. This information is needed and reasonable to allow the opportunity for inspection during construction by the agency or CFO. The information is available to the feedlot owner at no additional effort or costs. Sharing the information with the agency or CFO ensures that the feedlot owner is constructing the stockpile in compliance with the rules and within the time frame outlined in the rules or individual permit for the facility. It is reasonable that the regulatory authorities understand the construction activities taking place within their area and have the opportunity to do a construction compliance evaluation prior to the feedlot owner expending money for a system due to failure because of poor quality materials or poor construction.

Item F. Item F contains the agency proposal that permanent stockpiles comply with subpart 2, item D. This provision establishes special separation distances between the base of the stockpile and the seasonal high water tables. Just as explained in subpart 2, item D, the need to protect ground water from infiltrating liquids contaminated with manure is important to the use of the ground water for human consumption. It is reasonable that all stockpiles have similar locational standards as minimum goals for protection ground water.

<u>7020.2150 Manure Compost Sites</u>

Minnesota leads the nation in having the largest number of municipal solid waste compost facilities (six with several others being considered). Minnesota was one of the first states in 1990 to ban yard waste from being landfilled or incinerated and last year composted over 850,000 cubic yards of yard waste in over 150 yard waste facilities. Compost rules, as part of the solid waste rules (7035.2836) were revised in 1993 in order to adopt the U.S. Environmental Protection Agency biosolids metal standards (40 CFR 503) and to expedite marketing of the compost.

Despite the interest and success in composting residential waste streams, composting agricultural wastes including manure has been almost nonexistent. Only two manure compost permits have been issued in Minnesota, although there are 40,000 feedlots in the state. Ironically, agriculture is well-suited to composting: the amount and biodegradability of manure, coupled with the availability of land and the benefits of adding compost to the soil make animal feedlots ideal places to compost.

Benefits of adding compost to soil include improved manure handling, enhanced soil tilth and fertility, and reduced environmental risk. The composting process produces heat, which drives off moisture and destroys pathogens and weed seeds. With good management, it produces a minimum of odors. Farmers in eighteenth and nineteenth-century America practiced composting. Mechanization, chemical fertilizers and pesticides changed farming in the 20th century. Compost was perceived to be unnecessary and as a result, composting largely disappeared from farms. Compost is gaining in popularity on farms on the East Coast of the United States and, in California especially, among organic farmers. Composting can replace chemical fertilizers while protecting the environment as it converts the nitrogen contained in manure into a more stable organic form, which is less susceptible to leaching. Compost has also been found to reduce soil-borne plant diseases without use of chemical controls. The disease-suppressing qualities of compost are widely recognized. See Exhibit S-10.

The agency has received telephone calls from farmers who want to compost manure but are reluctant to do so because they believe a permit is required under all circumstances. This belief comes from the overall permitting requirements for small feedlot operations. In an effort to clarify when permits would be required under the revised rule and permitting system, a new section is proposed by the agency on manure composting. Basically, the short-term stockpile requirements must be met if composting on a section of land for less than six months, and the permanent stockpile requirements must be followed when composting on the same section of land for longer than six months. Therefore, a permit and requirements for a liner and runoff pond will not be required if the land under the composting material is re-vegetated every six months. An SDS permit is required if the site has manure composting on it from 1,000 animal units or more. In the event that the site meets the criteria for a CAFO, then an NPDES permit will be required.

Less leachate is produced from composting material than from simply placing manure in a pile. Little, if any, air passes through a pile of manure. Under these circumstances, the anaerobic microorganisms dominate the degradation that inevitably takes place. All of the undesirable effects associated with anaerobic degradation occur: low temperatures, slow decomposition and the release of hydrogen sulfide, and other malodorous compounds. Water in the pile is not vaporized by high temperatures and the pile remains wet and anaerobic. This combination produces leachate, which contains a liquid with partially degraded organic compounds.

A study of compost utilization as a soil amendment for crops was conducted by the University of Minnesota under the direction of the Minnesota Office of Environmental Assistance. This study includes data on the relative leaching characteristics of compost. The study concluded that contaminants are less likely to leach from composted manure than raw manure. See Exhibit S-14.

Subpart 1. In subpart 1, the agency proposes requirements for owners who compost manure. The provisions establish that the stockpile requirements are the minimum standards for compost site locations, design and construction. Additionally, subpart 1 states that compost made from manure and solid waste must comply with the solid waste compost rule part 7035.2836, subparts 4 to 7 (the solid waste compost rules), and that owners composting dead animals comply with the Board of Animal Health rule part 1719.4000.

This is needed to direct composters to the appropriate regulations, dependent on their respective feedstocks. It is reasonable to have farmers follow the solid waste compost rules if they are composting solid wastes with their manure. It is appropriate that the more protective standard apply when combining feedstocks to produce a compost product.

While the agency is not responsible for the management of dead animals, it is reasonable that feedlot owners, who have more direct relationship with the agency relative to managing their facility, be directed to the proper Board of Animal Health rules, the agency with jurisdiction over the proper management of dead animals. The agency believes that providing the information is a service to animal feedlot owners and assists in ensuring that all aspects of the feedlot operation are maintained to protect human health and the environment.

Subpart 2. Subpart 2 lists the operational requirements for composting manure. Item A directs the owner to the stockpile portion of Minn. R. ch. 7020, which is part 7020.2125. The animal feedlot owner must establish the compost site in the same manner as one would locate, design and operate a stockpile. The requirements of part 7020.2125 are discussed in this SONAR for that section and immediately precedes this discussion. Thus, if a person is composting manure for 180 days, the site would need to be re-vegetated for one growing season prior to reuse. The re-vegetation allows the plants to utilize any nutrients in the soil from the composting material. If inclement weather prevented the timely removal of the compost, a feedlot owner could write the agency or county feedlot pollution control officer and request an extension for up to one year. The next batch of composting material would have located away from the previous site in order to allow for vegetation to grow at the previous location. If a person decided not to move the location of the composting material every six months, a liner and diversion structures would need to be constructed to place the manure on.

Just as the stockpiling of manure has risks associated with it, so does the development of a compost site. It is important that the risks be minimized. Since composting is simply a more active management program than stockpiling manure in that turning and working with the pile are standard, it is reasonable that similar operational and locational standards be used to minimize risks.

Item B. In item B, the agency proposes that a compost site even operating as a short-term stockpile, less than six months at any one location, be required to meet the diversion standards applicable to permanent stockpiles. This provision is necessary because successful composting requires that temperature, moisture and air be maintained at proper levels. By establishing a diversion system around the compost site, the animal feedlot owner will be able to control the amount of surface water run-on and may then estimate moisture content by matching existing moisture with final product and account for precipitation in the operations. Until the composting process has proceeded to final compost, the manure on a compost pile has similar risks associated with it as raw manure stockpiled. Thus, it is reasonable that, for the protection of human health and the environment, similar standards apply.

Item C requires that one of three systems be used for composting and ultimately for regulating pathogens in the compost. A major advantage of composting manure is the pathogen kill that occurs from the intense heat and resultant elevated temperature during aerobic composting. Composting manure offers protection against E. coli, a bacterium associated with waste from the intestinal tract and in manure. E. coli has been found in wells not adequately protected. In addition to proper locating and operating of manure management systems, another protection measure is to compost in a manner that kills the bacteria. There are not waiting periods when applying raw manure to food chain crops or crops grown for human consumption although there are restrictions for spreading biosolids, which is generated from treatment of human wastewaters and has similar bacteria as manure. Subitems 1 to 3 establish the type of composting operations the agency believes are sufficient to kill E. coli and other pathogens.

A USDA-researched method referred to as a process to further reduce pathogens (PFRP) describes the procedure to kill pathogens. The use of PFRP for regulating pathogens in biosolids was adapted by EPA in the final 40 CFR 503 rule which was published in the Federal Register on February 19, 1993. This operational standard was based on extensive experimental data and years of experience and, in the judgment of EPA, is protective of public health and the environment. See Exhibit S-15.

The choice of composting method for most farms is usually windrows or aerated piles, as these methods are much less costly than an in-vessel composting method. Windrows can be turned with a bobcat, front-end loader or bucket loader on a tractor, equipment that typically exists on a farm. It may be possible for a farmer to avoid the expense of special windrow turners by adapting farm equipment (augers, conveyors, harvesting machines, etc.) to mix and move the composting material. For a full discussion of these composting methods, chapter 4 in the On-Farm Composting Handbook should be reviewed. See Exhibit S-10.

Subitems 1 to 3. The three options for meeting PFRP are a windrow method, static aerated pile method or enclosed vessel method. These methods are identical to those required of solid waste or food waste composting under Minn. R. pt. 7035.2836. The system used is at the discretion of the animal feedlot owner but must have the ability to reach an operating temperature of 55 degrees Celsius (131° Fahrenheit) for a specified period of time. The temperature standard ensures not only that pathogens are killed, but that proper aerobic conditions are occurring in the pile and with those, the proper operation of the composting process. These options are discussed in detail in the SONAR for Minn. R. pt. 7035.2836, dated February 23, 1988.

Subpart 3. Subpart 3 lists the recordkeeping and reporting requirements the agency believes are necessary for animal feedlot owners required to apply for and obtain a permit. A permit is required according to criteria under part 7020.0405, subp. 1, item A or B. A permit is required for operations composting 1,000 animal units or more of manure at any given time.

Item A. Owners of permitted operations must, according to item A, analyze and maintain records for pH, moisture content, particle size, NPK and soluble salt content of the final compost product. This information should be provided to compost users to help assure successful compost use and satisfaction with the results from using the compost. The parameters are also important for managing potential phytotoxicity and proper land applications. For these reasons, the solid waste compost rules require the pH, moisture content, particle size, NPK ratio and soluble salt content to be analyzed for a solid waste compost as well (Minn. R. pt. 7035.2836, subp. 5, item J, subitem 4, units a to e). The importance of these parameters is further discussed in the SONAR for part 7035.2836, dated February 23, 1988.

Carl Rosen, Ph.D., a soil scientist in the Department of Soil, Water and Climate at the University of Minnesota, lists these parameters and others as those to measure in a compost in his paper, "Horticultural Use of Compost: Key Factors to Measure." See Exhibit S-11. According to Dr. Rosen, "the primary goal of composting is to end up with a less odorous, and more stable organic matter source that can be beneficially used. General uses of composts for these purposes have been as a soil conditioner, mulch, sphagnum peat substitute in potting mix and a slow release source of nutrients. Understanding what compost properties to measure and how to interpret the measurements is essential to ensure success in growing plants with compost amendments… Of these key properties, high pH, excessive salts and lack of nitrogen are most likely to cause problems for plant growth. Measuring all the key properties prior to planting will help to improve the chances of success when using compost for production of horticultural plants." See Exhibit S-11.

It is reasonable to require testing for and maintenance of records for these different parameters as it will be of benefit to the composter and end user to determine how and where the compost can be utilized. If the compost is used inappropriately (for example, an alkaline compost on a pH-sensitive crop that is acid loving) and is phytotoxic to the crop, records will be of benefit to determine what went wrong and how to correct the problem.

Customers may request information on these qualities and it will benefit the composter to have this information available. It also demonstrates to the county, neighbors and agency that a quality product is being produced.

Item B. The agency in item B requires that if an owner has an NPDES or SDS permit, the required annual report must include the quantities and sources of manure and bulking agents delivered to the facility; the temperature and retention time; and the information recorded under Item A in the annual report. It is reasonable to require that composters supply this information if they met the criteria and are issued an NPDES or SDS permit as those permits require disclosure of the amount and source of manure. Understanding how manure is being managed, either through composting or direct land application, will assist the agency, delegated county and producers in looking for problem areas and opportunities to improve the management system.

The amount of bulking agents (i.e., straw, sunflower hulls, corn stalks, and other carbonaceous material) is needed along with the amount of the manure composted to calculate if aerobic conditions are most likely being met. The manure in most cases will need an equivalent amount of bulking material to allow for passive aeration of the pile. Documenting the time and temperature of the PFRP process is important and highly desirable from the farmers' point of view to demonstrate that pathogens have indeed been killed. The temperature and retention time could be made available to customers as well, which should be an advantageous selling point. It is reasonable for the farmer to include this information in any required report as it demonstrates that proper composting operations have occurred and the data is required to be taken by the farmer in any event. Finally, it is also reasonable to require that the farmer include the records for pH, moisture content, particle size, NPK and soluble salt as these parameters have already been required to be tested for in each final batch of compost. It is needed by the MPCA to determine that a quality product has been made and should be of interest to customers as well.

7020.2225 Land Application of Manure

Applying manure to the land has many benefits to soil physical and chemical properties. Manure adds nutrients to soils that are essential for plant growth. Manure can increase soil organic matter in soils with very low organic matter and can improve soil structure and tilth. Research has shown that manure application can also slow the rate of soil erosion. However, research and monitoring has also shown that land application of manure can also result in pollution of Minnesota's surface and ground water. See Exhibit A-1.

Excess nitrogen applied to the soil will result in elevated nitrate transport to aquifers or tile drainage waters. Runoff from a field that has had manure applied can cause acute problems such as fish kills or chronic problems due to excess nutrient and bacteria transport to lakes and streams. This pollution can result even when manure is applied at acceptable rates, especially when manure is applied to the ground surface near waters.

The existing rules do not establish standards that adequately protect waters from the impacts associated with manure application activities. Therefore, the agency proposes to replace the existing general statements in the rules with a more specific set of standards. The land application standards being proposed have gone through an extensive development process that involved the parties directly impacted by this rule. A summary of this process follows, beginning with some historical background information about manure application regulations and guidelines in Minnesota.

The land application requirements, under the existing rules part 7020.0400, subp. 3, state that animal manure shall "be applied at rates not exceeding local agricultural crop nutrient requirements except where allowed by permit." The rules also require, under part 7020.0500, subp. 2, item C, that all feedlot permit applications include a manure management plan that describes "manure handling and application techniques, and acreage available for manure application." No other specific requirements are provided in the current agency feedlot rules regarding land application of manure.

In 1981, the agency developed voluntary guidelines for manure application to provide more specific recommendations. A draft revision of the guidelines was developed in 1992. While the guidelines were intended to foster voluntary adoption measures to protect water quality, it was recognized that certain language from past guidelines had been incorporated into some local feedlot ordinances and provisions in some permits.

A Feedlot Advisory Group (FLAG) was established by the agency in 1989 and representation included producer and farm groups, environmental organizations, and state, federal and local agencies. The purpose of FLAG was to provide increased discussion and coordination regarding concerns surrounding animal production and water pollution and the agency's efforts in this area. A Land Application of Manure Task Force was established by FLAG to review existing guidelines and make recommendations for revising the agency's manure application guidelines. The task force was also asked to provide comments and direction regarding feedlot rule revisions pertaining to manure application. The Feedlot and Manure Management Advisory Committee (FMMAC), which replaced FLAG, directed the task force to continue working on the guidelines and rules.

Following eight task force meetings over a two-year period, a report on manure application guidelines was submitted to FMMAC in August 1995. The Manure Application Guideline Report was unanimously approved by FMMAC in November 1995. See Exhibit L-1. The resulting guidelines were supported by a document entitled "Basis and Justification for the Minnesota Land Application of Manure Guidelines" dated July 1995. See Exhibits A-1 and L-2.

With a technical foundation established through the guidelines development process, the Land Application of Manure Task Force began in September 1995, discussing possible rule language related to manure application. At a minimum, the task force was to provide recommendations for greater definition of the existing Minn. R. ch. 7020 "crop nutrient needs" language and the manure management plan language. The Task Force was also to consider other options and rules for ground water and surface water quality protection.

The Land Application of Manure Task Force members working on rule development were primarily the same members who participated in the task force which developed the manure application guidelines. Task force members, representing varying backgrounds, representations and viewpoints, worked together to develop rule recommendations which were reasonable, environmentally protective, understandable and, to the degree possible, enforceable. The various viewpoints were not equally represented on the task force, and therefore the goal of the task force was not to seek majority opinion. Rather, the intent was to create a forum where varying viewpoints and experiences could be voiced, discussed and considered by the agency when drafting the recommended rule revision and report to FMMAC.

Most task force members desired a set of rules which were fair, meaningful, justifiable, and flexible. Some task force members also desired rules that were fairly comprehensive from an environmental protection standpoint. These aims tended to move the feedlot rules away from simplicity. Realizing that overly complex rules would be difficult to communicate to people and would be less likely to be followed, the goal was to develop rules that met a reasonable balance of simplicity and specificity.

The task force recommendations for rule language were developed during five meetings between September 1995 and June 1997. After much discussion and several revisions, the task force was able to reach general agreement on much of the proposed rule language. There were, however, a few issues for which agreement was not completely reached by all members. The principle issue of disagreement related to requirements for spreading around the numerous open tile inlets, which are used in the state for water drainage purposes.

A July 1, 1997, report to FMMAC described the Land Application of Manure Task Force recommendations concerning rule revisions. See Exhibit L-3. The FMMAC members suggested a few minor changes to the task force recommendations. The proposed rule language is based primarily on recommendations made by the Land Application of Manure Task Force, but also reflects comments made by FMMAC members, and comments made during and following several public meetings as draft rules were presented at numerous seminars around the state. The current proposed rules in part 7020.2225 regarding land application of manure were approved by FMMAC during the October 11, 1999, meeting.

Subpart 1. In General.

Item A. Under item A, the agency proposes to outline in general terms when manure application practices are not acceptable, and what is expected of cropland managers who receive manure from other feedlots. It is reasonable to provide this information in rule to avoid miscommunication and allow feedlot owners to plan for the necessary tasks involved in land application. Additionally, codifying the guidelines provides for consistent implementation and eliminates the need for most facility owners to receive individual permits to address land application requirements.

Item A, subitem 1. Subitem 1 addresses placing manure directly into waters of the state. The direct application of manure into waters and conduits to waters is easily avoidable with little to no cost to producers, and can lead to acute or chronic water quality problems.

The agency is proposing to allow manure application onto seasonally saturated soils which are seeded to annual farm crops or crop rotations involving pasture grasses or legumes. Allowing land application of manure in these areas is reasonable because they do not serve as aquatic habitats that can be negatively affected by manure application. Additionally, these areas do not meet the definition in the state water quality standards for wetlands (Minn. R. pt. 7050.0130, item F) because they do not support a prevalence of hydrophytic vegetation. Rather, they are cropped land which will need additional nutrients, either commercial fertilizer or manure, for optimal growth.

Item A, subitem 2. Subitem 2 is needed to address manure entering waters of the state indirectly as rainfall or snowmelt waters carry manure off the field in runoff waters. The state water quality standards prohibit sewage, industrial waste, or other wastes from being discharged from either a point or a nonpoint source into the waters of the state in such quantities or in such manner to cause pollution, Minn. R. pt. 7050.0210, subp. 13. See Exhibit L-4. The agency proposes to prohibit pollution resulting from runoff water containing manure from entering waters of the state. This prohibition is reasonable because it is consistent with the pollution prohibition standard under Minn. R. ch. 7050. Including this language in the rules clarifies that land application practitioners have the responsibility for ensuring that manure is not washed off the field by runoff from precipitation and snowmelt such that it causes water pollution.

The agency proposes to prohibit pollution of waters of the state resulting from rainfall and snowmelt transporting manure from the land application sites. Some minor amount of manure often will be transported from land application sites to surface or ground waters during many snowmelt and normal storm events, even when all MPCA and University recommendations are being followed. For this reason, it was considered unrealistic to include rule language prohibiting all manure from entering waters of the state during subsequent runoff events. The agency proposes that Minn. R. ch. 7020 include language stating that manure can not enter waters of the state at such quantities as to cause pollution.

Item B. Manure application into road ditches is prohibited under Item B. Since a majority of road ditches are waterways that convey water to lakes and streams, the prohibition is needed to prevent water pollution when manure is applied to these areas. Even though not all road ditches lead to waters of the state, prohibiting use of all road ditches for the application of manure is reasonable because establishing and maintaining a process for approving ditch use would not be administratively feasible, and few farmers have a need or desire to apply manure into road ditches. In addition, ground water from disposal practices on ditch sides may cause runoff to the lowest part of the ditch. In those areas, applied manure can pool after precipitation events and then exceed the nitrogen uptake of the vegetation in the lower ditch areas. This could give rise to violations of Minn. R. pt. 7060.0600, subp. 1 or 2.

Some road ditches are not waterways and manure could be applied into such ditches without adverse effects on surface water quality. However, careful inspections of road ditches are needed to determine which ones lead to waters and which do not. Producers will apply manure into road ditches for several reasons, including nutrient additions to increase hay crop yields in road ditches; preventing soil compaction since equipment for application can be driven on the roads while spreading into road ditches; and during certain times of the year (e.g., later winter and early spring) manure storage systems begin to fill and it is very difficult to get equipment into the farm fields for manure application. In McLeod County, a local ordinance prohibited spreading in road ditches without authorization from the county. Requests for approval to apply in road ditches were only received for a couple miles of road ditches.

Due to concern from producers for restricting application in all road ditches, the Task Force recommendations to FMMAC included the following proposed rule language: "Manure application into road ditches is prohibited, unless the road ditch is not a drainage course, waterway or water course that leads to a water of the state and written authorization is obtained from the agency or delegated county authority." The agency in reviewing this language believed that a process for road ditch inspections and written authorization would not be practical because:

- Added demand it would pose on limited staff resources to conduct ditch inspections;
- Need for short turnaround times for approval decisions;
- Experience that most road ditches will lead to waters of the state; and
- Ground water quality can be threatened in road ditches that do not lead to waters of the state.

For these reasons, the agency staff recommended that the rules do not allow exceptions for road ditch application.

Item C. Item C is needed to clarify that all feedlots and all manure application must meet the requirements of part 7020.2225, except for when the rules explicitly exempt feedlots below certain animal unit thresholds. It is reasonable to match the requirements to the risk, as has been done throughout the proposed rule.

Item D. Under Item D, the agency proposes to identify the requirements of people who receive manure from other feedlots. This item is needed to clarify that those who do not own feedlots must meet certain requirements when they receive manure from livestock or poultry operations for use as a domestic fertilizer. The proposed requirements are reasonable since the environmental protection requirements applicable to manure application on land owned or leased by the feedlot operator would be generally consistent with requirements of manure, which is sold or given away to land not leased or owned by the feedlot operation. The 100 animal unit threshold is consistent with the 100 animal threshold for when a manure management plan must be developed in subpart 4, item A.

Item D, subitem 1. Subitem 1 clarifies that all feedlot owners have responsibility to ensure that the manure generated from their facility is handled in ways that do not cause pollution. Specifically, Subitem 1 requires the landowner receiving manure for land application to comply with the manure management plan of the original feedlot generating the manure. When manure is sold or given away, the feedlot owner can specify certain environmental protection practices that must be followed as part of the agreement to receive the manure. Subpart 4, item E identifies the minimum items of a manure management plan that are required when ownership of manure is to be transferred. Subitem 1 is needed to clarify for the receiver of the manure that they have a duty to comply with the manure management plan developed by the owner of the feedlot where the manure was generated. The agency considered establishing a program that required tracking and signatures at each step in the manure transfer process. However, the agency believes that a program similar to the cradle to grave approach for other waste types was not warranted with regard to manure management. Subitem 1 is reasonable because it clarifies that the feedlot owner is responsible for ensuring that manure generated at a feedlot will be handled in a manner consistent with state and local laws and environmental protection policies, without significant administrative oversight. The person receiving the manure maintains the right to reject the manure if they do not wish to comply with the manure management plan.

Item D, subitem 2. Subitem 2 requires when the owner of land where manure will be applied either follow the manure management plan developed by the feedlot owner offering the manure for use or develop a management plan for land application specific to the land where the manure will be applied. When ownership of manure is transferred, the ability of the feedlot owner to develop specific and comprehensive manure management plan is lost or limited. Much of the information in a manure management plan is largely dependent on the crops to be grown, cropping history, and site-specific soil conditions. This information is known by the cropland manager where the manure is to be applied, and is not known by the feedlot owner or operator who transfers ownership of manure. Subitem 2 is needed so that a complete manure management plan is available from the combined manure management plan information from the feedlot owner and the person owning or managing the cropland where the manure is to be applied. The manure management plan is a critical factor in protecting human health and the environment from impacts associated with the improper management of manure. Subitem 2 is reasonable since it makes the manure management-planning requirements similar for transferred and non-transferred manure. The planning information to be supplied by the receiver of the manure can be developed any time prior to application of the manure.

Subpart 2. Manure nutrient testing requirements. The agency proposes that manure from all manure storage systems and stockpiling sites generated from feedlots with more than 100 animal units to be tested for nutrient content before it is land applied. The testing requirement is needed because all manure does not contain the same nutrient characteristics. The concentration of key nutrient components (nitrogen and phosphorus) must be identified to avoid manure application rates that create conditions for a potential water pollution problem. Manure nutrient testing results show extreme variability in manure nutrient content among feedlots. Manure applications rates determined only using published average manure nutrient content values often results in excess nutrient additions or result in insufficient crop nutrients being applied if the actual nutrient content in a specific manure is less than book values. If applied in excess, the remaining nutrients are then available for moving into surface water or ground water supplies. Manure nutrient testing gives producers greater confidence in using the manure to supply crop nutrient requirements.

Testing is not proposed for stored manure generated from feedlots with less than 100 animal units. The amount of manure from these facilities is such that it has been well tested and using the average manure nutrient concentrations obtained from publications is recommended. The cost and labor involved in manure nutrient testing can be high in proportion to the potential water quality damage that may result from as light over-application of such limited quantities of manure. Some task force members stated that it is not reasonable to expect the small feedlot operators to test all stockpiles of manure. Many farmers have numerous small stockpiles that each have different nutrient contents. The nutrient content, even within the same stockpile, usually varies. The environmental protection afforded by manure testing compared with using book values for these small stockpile sites would not be very great in relation to the uncertainties and cost associated with manure testing. Since most semi-solid and liquid manure storage systems in Minnesota hold manure from more than 100 animal units, most of the liquid and semi-solid manure in the state will need to be tested in accordance with the proposed rule.

Even with manure testing, there is still some uncertainty regarding manure nutrient content. Reasons for the uncertainty include the large variability within and among manure storage sites; the variability in nutrient content with different seasons and climate; the laboratory analyses that are usually not completed until after the manure has already been applied; and the errors in laboratory analysis. One recent study showed that 17 sub-samples of solid beef manure are needed to obtain an analysis that is within 10 percent of the true nitrogen content. See Exhibit L-13.

The Land Application of Manure Task Force originally suggested that manure nutrient testing be conducted at all manure storage sites generated from 50 animal units, rather than the 100 animal units currently being proposed. The primary reason for the 50 animal unit threshold was to remain consistent with other MPCA permitting thresholds at 50 animal units. Comments from FMMAC members and others in the regulated community recommended using a higher threshold, such as 300 animal units, due to the uncertainties noted above and the labor and costs associated with obtaining a more accurate test result. A 100-animal unit threshold is reasonable since it would require sampling of most liquid manure storage systems in the state and all of the larger stockpiles of manure, but would not require the rigorous sampling to obtain an accurate nutrient analysis on each small solid manure stockpile site.

Item A. During the first few years of manure testing, there is a need to test at a greater frequency and in more locations to determine the range and variability in nutrient content from the animals at a specific feedlot. After obtaining results from three consecutive years, the feedlot owner will have the information needed to determine the appropriate ongoing testing procedures and testing frequency. This item is needed to establish the average manure nutrient content for the individual farm and the variability from year to year. Three years is a reasonable amount of time since it balances the need for accuracy, likely to be somewhere in the 5 to seven year range, and the need to be comfortable that the results are relatively accurate. A one or two year cycle will not account for weather changes or perhaps some feed alterations being completed. The third year helps shift the balance in one direction or another. It must also be clarified that the feedlot owner may sample annually, if they believe it important.

Item B. Item B requires that the manure needs to be re-tested when any change occurs in the feedlot operation or climate that would be expected to cause a change in manure nutrient content. The task force recommended that the rules should not force feedlot owners into using the test results as the absolute and only number when establishing land application options. Task force members stated that there needs to be some flexibility to allow the feedlot owner adjustments to the nutrient value considered in the development of land application options. Also, the task force recommended that feedlot owners be given some flexibility regarding the needed frequency of ongoing sampling. The needed frequency will be different for different operations. The proposed rules were written with the intent of allowing this flexibility. It is particularly important to test the manure following any change that would be expected to affect nutrient content. It is reasonable to establish in rule the minimum times considered appropriate to retest manure generated at a particular feedlot because results in testing manure when it is most beneficial for the feedlot owner and the environment. Once again, the rule does not prohibit more frequent testing by the feedlot owner but balances the need for information to land apply manure in an environmentally-sound manner and the cost of testing.

Item C. The task force recommended that there be some sort of a minimum frequency stated in the rules to make the rules more enforceable and so that producers do not forever rely on the initial three-year testing period required in item A. Therefore, the agency proposes that testing must be conducted at least once every four years as a check on the original testing completed. Item C is needed to ensure that the manure nutrient content does not radically change in an unexpected manner and so that the producer maintains confidence in the fertilizer value of the manure.

The cost to analyze manure for nitrogen, phosphorus and potassium averages roughly $25 per sample. If a producer has three manure storage systems, the costs during the first few years for nutrient analysis will be approximately $200 to $500. Minimum costs every four years would be approximately $75 to $120. Feedlot owners or the recipient of the manure for land application may achieve commercial fertilizer reductions or improved crop yield due to the manure testing, possibly off-setting the cost of manure testing and resulting in a net financial gain for some producers. It is reasonable to expect the feedlot owner to understand the nutrient content of the manure produced and incorporate this information into the management plan for the manure. Additionally, since many forces may create the need to change feedstocks, breeds, etc., it is reasonable that a regular accounting of the manure nutrient value be made.

Item D. A manure nutrient analysis is useful to the producer only if the methods used to analyze the manure are reliable. Item D is needed to ensure that manure is not over-applied or under-applied due to inaccurate testing methods. The Minnesota Department of Agriculture certifies laboratories for manure nutrient testing. At the time of this writing, the Minnesota Department of Agriculture has certified 24 laboratories in Minnesota. It is roughly estimated that 20,000 feedlots will need manure testing under this subpart. Several task force members stated that the agency needs to allow field-testing methods that are proven to be accurate for manure analysis, rather than only allow laboratory analyses. Thus, the proposed rules contain a commissioner-approved on-farm testing option for manure. On-farm testing is advantageous since the results are available immediately and usually cheaper than tests completed by a laboratory. These methods can be proven by comparing on-site testing results with the results of a certified laboratory. This approach is reasonable as it guarantees the feedlot owner and agency's confidence in the resulting numbers and allows for controlled innovation for reducing cost and time in testing manure.

Item E. Nutrient concentrations within any given solid manure stockpile or liquid manure storage system is variable. For example, if a sample of manure was taken from the top of a stockpile or the top of a liquid manure pond, that sample would not be representative of the nutrient content of the entire stockpile or liquid system. A misrepresentative sample can lead to over-application or under-application of nutrients. Procedures have been established and published by the University of Minnesota Extension Service for taking a representative manure sample from solid or liquid storage areas. See Exhibit L-6. Item E is needed to prevent procedures that would lead to excessive nutrient application and subsequent loss of nutrients to ground water or surface water. Item E is reasonable since it is in the best interest of the producer to obtain the most accurate and representative manure sample possible to ensure economically and environmentally sound nutrient management practices.

Subpart 3. Nutrient Application Rate Standards. The agency proposes to establish a standard for the amount of nitrogen that can be land applied. The agency also proposes to establish a standard for the amount of phosphorus that can be applied in special protection areas in accordance with subpart 6, item B.

Item A. The agency proposes to limit manure application to a rate that does not exceed expected crop nitrogen needs for non-legume crops and expected nitrogen removal for legumes. The standard of nitrogen application is needed to ensure that the capacity of a land application site to utilize the manure is not being exceeded and thus, allow excess nitrogen to move into ground water or surface water via tile lines. It is reasonable to use the expected crop utilization of nitrogen because the rate is based on the site-specific crop nutrient needs and expected nitrogen available to the crop at that site. Averaged or published data cannot account for the specific conditions under which land is being managed and thus, may result in over or under application rates needed to ensure that a successful crop results.

In order to understand the need and reasonableness of nutrient rate standards in Item A, it is important to understand how nitrogen is taken up by plants and moves in the soil. A discussion on plant uptake of nitrogen follows.

The total nitrogen in manure is not available for crop uptake. Much of the nitrogen is bound in organic forms, although varying amounts of plant available ammonium nitrogen are also present. The organic nitrogen will gradually change into inorganic forms of nitrogen (ammonium and nitrate) and is now available to plants. This process involves the conversion of organic nitrogen into ammonium followed by a conversion of ammonium into nitrate. Factors affecting these transformations include soil microbial populations, temperature, moisture, rate of application, method of application, soil characteristics and type of manure. Estimates based on agricultural research can be made of the percent of organic nitrogen that is converted to ammonium. The ability to estimate plant available nitrogen from manure has improved with additional research and may be further refined from the results of future research.

Legume crops, such as alfalfa and soybeans, are able to produce their own plant available nitrogen from atmospheric nitrogen, and therefore do not need additional nitrogen. However, when soil nitrogen is available to legumes, they will use that available soil nitrogen rather than using atmospheric nitrogen. This allows legumes to receive considerable quantities of manure without leaving much excess nitrogen in the soil.

Nitrogen movement in soil is related to the form of nitrogen existing in the soil. Organic nitrogen, which is immobile in the soil, is converted to ammonium when the soil temperature is above about 50°F. Ammonium nitrogen can be held by the soil as a result of the soil chemistry, moving very little until the soil is over-saturated with ammonium. Ammonium, under the presence of oxygen, will convert to nitrate, which moves freely in the soil along with soil water. For example, a heavy rainfall could potentially move much of the nitrate nitrogen from soil to ground water. The excess plant available nitrogen in the soil following crop nitrogen uptake can partially move through the soil towards ground water in the form of nitrate.

Existing rules prevent manure application in excess of crop nutrient needs, but they do not specify which crop nutrient should be considered. Applying manure based on crop nitrogen needs will be different from application rates based on phosphorus, potassium, zinc or other micronutrient needs. Application rates based on nitrogen will usually allow for greater manure application rates than rates based on other nutrients. Excess soil nitrogen can cause water quality problems in most areas of Minnesota; whereas, the environmental effects of excess phosphorus are not as universally problematic.

Item A, subitem 1. Crop nitrogen needs and removal rates and nitrogen availability from manure and legumes have been determined from University research and are important to consider in preventing excessive nitrogen application rates. The agency proposes that the crop nitrogen needs, removal rates, and the expected amount of plant-available nitrogen from manure be based on the most recent University of Minnesota recommendations. See Exhibit L-7. To establish a state-wide standard for nitrogen application based on crop utilization, the agency references in the proposed rules field-tested methods for estimating the crop nitrogen needs and removal as affected by crop yield goals, previous crop, and soil organic matter levels; and for estimating the fraction of manure nitrogen that becomes available for plant use during the first and second years after application. The agency proposes not to publish a specific rate table in the rules due to the widespread availability of University of Minnesota recommendations at county extension offices. If specific rate tables were proposed, the agency would need to consider rules revisions when new research results are found and recommendations are refined. Establishing these tables outside of the proposed rules is reasonable because the table rate values are not developed by the agency, but are based on the research done by the University of Minnesota and produced in cooperation with other agencies. Thus, the recommendations are made to match the plant needs and the ability to meet these needs by a neutral party to the regulatory process not the agency or delegated county. Additionally, the University of Minnesota's research will ensure that science would be used in making these recommendations.

Item A, subitem 2. Estimates of plant available nitrogen from manure are also available from University research. See Exhibit L-7. However, site-specific soil, crop rotation, and climate conditions can result in University estimates that over-predict or under-predict the amount of nitrogen available from manure. In addition, manure nutrient test results for solid manure are often off by 10 to 20 percent. For these reasons, the task force strongly recommended that the producer not be necessarily locked into one number for nitrogen as that expected to be available from a particular manure source, and consequently, recommended the allowable 20 percent deviation.

It is not intended that standard practice be to apply manure at rates 20 percent greater than University of Minnesota recommendations, since the University has already developed the recommendations to provide sufficient nutrients to crops under most situations. Subitem 2 is needed, however, to allow some degree of flexibility to account for the thousands of soils and the climatic variability found in Minnesota. It is reasonable to allow this deviation to prevent manure users in suffering crop yield losses as a result of following the proposed rules meant to protect human health and the environment. Additionally, subpart 5 requires that records be maintained by the user of the manure. These records will provide information on the actual amount of manure applied and why deviations may have occurred. The importance of these records is explained later in this SONAR under subpart 5, Recordkeeping.

The agency realizes that some extreme situations and site conditions exist where deviations greater than 20 percent are necessary to meet crop nutrient needs, and has made an allowance to exceed the 20 percent deviation when nutrient deficiencies are found. For the reasons stated above, this is a reasonable approach to establishing nutrient levels for manure and ultimately the application rates. Since under the permitting approach defined in the proposed rules, do not require the manure management plan to be submitted by every feedlot owner, it is reasonable to establish when specific criteria may be altered by the feedlot owner without first obtaining the agency's approval. This method of managing manure places the responsibility on the person most knowledgeable about the conditions under which manure is being applied to cropland.

Item A, subitem 3. There are many possible sources of soil nitrogen, in addition to manure. Often the manure alone does not cause excess nitrogen to remain in the soil, but it is the combination of nitrogen from manure, commercial fertilizers, soil organic matter, and plowdown of the previous crop that results in soil nitrogen levels much greater than crop nitrogen needs or uptake. The agency proposes under subitem 3 to clarify that the application rate for a site is limited by the combination of all nitrogen sources.

The Minnesota Department of Agriculture has interviewed livestock producers in different regions of the state. See Exhibit L-14. The findings from these interviews show that excessive nitrogen rates are not typically due to over-application of manure or over-application of commercial fertilizer alone. The most common reason for over-application of nitrogen is the combination of manure and commercial fertilizer, and altering the application rates to adequately account for nitrogen leftover in the soil from growing legumes during the previous year.

Thus, the agency believes it is reasonable to establish the components that are necessary to develop a balanced nutrient management system not just a manure application plan. Additionally, by understanding all factors contributing to the nitrogen levels on a particular soil will all the producer to save money by reducing or eliminating the most costly component.

Item B. The agency proposes that manure applied to land in special protection areas must comply with the phosphorus rate requirement described under subpart 6, item B, if a permanent vegetated buffer is not planted between the water or channel and the field receiving manure. The phosphorus requirement was placed under subpart 6 instead of this item so that all land application requirements for special protection areas are consolidated in one area in the rules. The consolidation is intended to make it easier for persons using the rules.

The Land Application of Manure Task Force agreed on the need to limit phosphorus build-up in soils along surface waters and channels to surface waters. Both the task force and FMMAC also had considerable discussion of phosphorus application rate standards on land away from these special protection areas. These discussions are summarized in the following section.

If manure could be economically distributed across the state, the state would need much less commercial phosphorus fertilizer to meet crop phosphorus needs. Most current manure application practices are focused on applying manure based on the crop's nitrogen needs. This practice often results in two to four times more phosphorus being applied than the crop will remove, and, for some solid manures, up to 15 times more phosphorus is applied than is removed by the crop. In general, soil phosphorus levels increase when manure is continually applied at nitrogen-based rates.

Even without any manure or fertilizer additions, it is estimated that more than one-half of Minnesota’s soils already have enough phosphorus to meet the crop's phosphorus needs. As soil phosphorus levels increase from added manure or fertilizer, there is a corresponding increase in runoff phosphorus concentrations. Phosphorus added to surface water will lead to additional weed and algae growth, which can subsequently result in lower aquatic oxygen levels. Thus, it is reasonable to manage manure application on those areas most sensitive to runoff from fields receiving too much phosphorus.

Phosphorus is most likely to move into waters from the land adjacent to surface waters and channels leading to surface water. See Exhibit L-9. There are more uncertainties about the effects of over-application of phosphorus further up in the watershed away from waters and channels. Many watersheds have considerable amounts of phosphorus that do not have much runoff, or are located in areas where there is little risk of runoff to surface waters or channels leading to surface waters, particularly, when the manure is injected.

The primary reasons for not placing strict phosphorus control restrictions on the land more than 300 feet from surface waters include the uncertainties about how phosphorus travels throughout a watershed; how far phosphorus moves across the landscape; and what are acceptable phosphorus levels in soils throughout the watershed to protect water quality. Additionally, there are many concerns about the economic and social ramifications related to phosphorus restrictions on land outside of the surface water corridor areas. Finally, phosphorus transport and effects on receiving waters varies from area to area across the state and stringent phosphorus control measures may be better addressed through watershed planning efforts, local restrictions, and permit conditions.

Some of the socio-economic concerns about phosphorus based manure application restrictions include:

- Producers have set up their farms and farmland over the years with the assumption that manure could be applied at nitrogen based rates. Many farms do not have enough land to apply manure at phosphorus based rates.
- Manure hauling costs increase significantly when the manure has to be applied on fields further away from the barns. Phosphorus based rates would require additional land and thus additional hauling costs (and associated environmental costs with increased transportation distances).
- Many soils have high native phosphorus levels. Regulations requiring manure application to be based strictly on crop phosphorus needs would prohibit manure application, thereby causing hardship for numerous producers.

The task force considered requiring phosphorus rate limitations outside of the 300-foot special protection areas near surface waters and channels. Some task force members expressed environmental concerns about extremely high soil phosphorus build-up on all soils, including those located more than 300 feet from surface waters or channels. While the areas of greatest concern are those soils near surface waters or runoff channels, runoff waters and eroded soil sediment can move hundreds of yards before entering waters and channels with definable banks. In addition, phosphorus has been shown to move down towards ground water in some soils that have extremely high phosphorus levels. See Exhibit L-19. Once phosphorus reaches ground water, it can be transported to surface waters.

Depending on the assumptions of nitrogen volatilization losses, manure nutrient content, and crop nitrogen needs, it is possible for producers to meet the proposed rule requirements for manure application based on nitrogen, while at the same time greatly overloading soil phosphorus. For example, if it is assumed that alfalfa can use 300 pounds of nitrogen, the manure contains 10 and 9 pounds per ton of N and P_2O_5, respectively; and nitrogen losses will be 50 percent, the rate of manure application to supply 300 pounds of plant available nitrogen would be 60 tons per acre. This would contribute 540 pounds of P_2O_5 per acre, which is nearly 500 pounds more than the crop needs. If this rate of application occurs year after year, soil phosphorus levels could build to extremely high levels. Extreme phosphorus over-application could also occur on corn-ground or other crops, if producers apply the manure strictly based on crop nitrogen uptake.

Several suggestions were made about how to deal with phosphorus outside of the 300 foot special protection areas, including:

- Upper limits on soil phosphorus test levels;

- Upper limits on manure application to legumes;
- Upper limits on annual manure phosphorus rates;
- Upper limits on long term phosphorus rates;
- Upper limits on short- or long-term phosphorus rates only when surface applying phosphorus;
- Restrict manure application to every other year or every third year when phosphorus exceeds a certain level; and
- Use education rather than rules to address phosphorus outside of the 300 foot special protection area zones.

While there is a potential threat of phosphorus transport to surface waters from outside of the 300-foot special protection zones, the literature indicates that the most critical areas for phosphorus control are those areas in close proximity to waters or channels leading to waters. See Exhibit L-9. The degree of phosphorus impacts also depends on the nature of the watershed soils, topography, land management practices, receiving waters, and other variables. See Exhibits L-5, L-10, L-11, and L-17.

Given the uncertainties and variability regarding water quality effects associated with soil phosphorus build-up; the socio-economic issues previously discussed; and other technical considerations, initial recommendations were that the rule revision for land outside the special protection areas consider annual phosphorus limitations only for surface application. With surface application, the manure is in a position to be more easily transported during subsequent snowmelt and precipitation events. When manure is placed below the ground surface, the manure, pathogen, ammonia and phosphorus transport risks are significantly reduced. See Exhibit L-2, pages 20 and 21.

In response to concerns about extremely high rates of surface application, the task force suggested the following language to prevent extreme over-application of phosphorus on land outside of special protection areas: "When surface applying manure without incorporating within 48 hours, the manure application rate must be limited so that the estimated plant available phosphorus provided by manure does not exceed five times the expected crop phosphorus uptake for any one year period, unless otherwise authorized by the Commissioner."

Several concerns were raised about this language including that the language:

- Increased the complexity of the land application rules and the disadvantages of this added complexity may outweigh the environmental protection which would result;
- Could have sent the wrong message out to producers that it is okay, or recommended, to apply manure at rates up to five times crop phosphorus removal;
- Did not account for site-specific conditions such as very low phosphorus soils or flat soils a great distance from waters and channels;
- Did not address phosphorus related issues associated with injected or incorporated manure; and
- Did not address that the rate of phosphorus application is only one factor affecting pollution from phosphorus, and the other factors are more influential.

Due to these concerns, which were expressed by the agency staff, FMMAC appointed a working group to review the phosphorus issue and develop, if necessary, revised recommendations to bring back to a subsequent FMMAC meeting. The working group included the agency staff, four researchers from the University of Minnesota and five FMMAC representatives. The work group decided to recommend that there not be a specific rate restriction for phosphorus outside of special protection areas. While the rate of application is the most important factor affecting transport of nitrogen to waters, the transport of phosphorus to waters is less affected by rate and more affected by soil type and soil phosphorus levels and the combination of the erosion control practices used; the proximity to waters; the land slopes; the method of application, and several other factors. The working group decided to recommend that soil phosphorus testing be required as part of the manure management plan and that this testing serve to trigger various actions as proposed in subpart 4, item B and subpart 4, item D, subitem 12. These recommendations were approved by FMMAC at the subsequent meeting and are further discussed in the corresponding parts of this SONAR.

Subpart 4. Manure Management Plan Requirements. The current rules require that a manure management plan be submitted with a feedlot permit application. The proposed rules add specific requirements on the information to be included in the manure management plan, and require these same plans to be updated and maintained at all feedlot facilities with more than 100 animal units. The additional requirements provide the information needed to ensure that manure is applied in a manner and rate that does not exceed crop nutrient requirements and subsequently present hazards to water quality.

A comprehensive manure management plan describes how manure generated at a given livestock facility is expected to be utilized to protect the environment while maintaining or improving soil and plant resources. The final manure management plan describes intended manure application locations, amounts, timing, methods and the information needed to determine environmentally, agronomically and economically acceptable application practices. A complete manure management plan accounts for crop rotations and nutrient crediting from previous years' crops and nutrient additions. An annual plan allows for the feedlot owner to adjust for changes in the amount of manure production, manure nutrient test results, crop rotations, soil nutrient test results, and other practices, which affect the available nutrient amounts or crop nutrient needs on fields receiving manure.

Given the complexities associated with manure management, it is extremely difficult to apply manure in an environmentally and agronomically-sound manner without some forethought, calculations and planning prior to applying the manure. A manure management plan is a fundamental tool used by producers to provide assurance that manure is applied at proper rates, times and locations. Combined with accurate records, the manure management plan also provides additional assurance that a particular facility is impacting the environment.

Step-by-step guidelines are available to assist a producer in developing their own manure management plan without the need for hired or government assistance. See Exhibit L-15. However, existing technical assistance experts in Minnesota Extension Service, Soil and Water

Conservation Districts, Natural Resources Conservation Service, and private crop consultants can also provide assistance to producers to develop a manure management plan.

Item A. Item A indicates who must complete a manure management plan and when the plan must done. The agency proposes to require a manure management plan to be prepared upon application for an NPDES, SDS or Construction Short-form permit. Additionally, subitems 2 and 3 require the development of manure management plans by feedlot owners for with more than 100 animal units, which are not required to apply for a permit. Manure management plans are currently required to be submitted as part of the application for a feedlot permit under part 7020.0500, subp. 2, item C. The existing rules have required a manure management plan to be submitted only when applying for a feedlot permit.

In addition to preparing a manure management plan for submittal with a permit application, the agency proposes that a current manure management plan is kept by owners of animal feedlots with 100 animal units or more. Item A requires feedlot owners with 100 animal units or more have a manure management plan, even if they do not have a permit. Requiring unpermitted feedlots to have a manure management plan is reasonable because it provides the information needed to ensure practices are used that abate water pollution and meet the requirements in subpart 1. It is just as important for those not applying for a feedlot permit to maintain an updated manure management plan as it is for those applying for a feedlot permit.

The Land Application of Manure Task Force recommended manure management plans to be prepared for anyone over 50 animal units rather than 100 animal units. This threshold was set to be consistent with the existing 50 animal unit threshold for permitting. Some task force members raised concerns about the reasonableness of requiring feedlot operators with 50 to 100 animal units to complete a manure management plan. This size of operation will not typically hire a consultant to complete a plan due to the expenditures.

The threshold of 100 animal units is reasonable since it requires manure management plans linked to most, over 75 percent, of the manure applied in the state. Also, the development of a manure management plan can be more realistically accomplished than if the threshold were 50 animal units. There are numerous feedlots between 50 and 100 animal units, yet they represent a relatively small fraction of manure generated in the state. The limited technical assistance for developing manure management plans will be more readily available with the threshold set at 100 animal units.

In the past, the manure management plans were not comprehensive, but showed that the producer had enough acreage available to potentially apply their manure at nitrogen based agronomic rates. The plans developed under the proposed rules will be more comprehensive when meeting the requirements under item D. A more comprehensive manure management plan is needed to consider all sources of nitrogen for purposes of maximizing crop productions, saving money, and ultimately protect human health and the environment. If the document meets the proposed standards under this part and the recordkeeping requirements of subpart 5, the feedlot owner will be able to answer compliance questions and adjust to crop needs in an effective manner. A comprehensive manure management plan is reasonable because it addresses human health and environmental concerns while providing the producer valuable information on achieving maximized cost production at least costs. Also, while the proposed rules define what should be in the manure management plan, they do not limit the information nor detail how the plan should be written. This allows the producers to develop a manure management plan most useful to their operations and not to the agency's review staff.

The agency proposes to phase-in the requirement for having an updated manure management plan. There will be some cost to producers who seek outside help from consultants in order to complete the manure management plan. In some cases, it is expected that this cost will be offset by fertilizer savings realized from improved nutrient management practices. Technical assistance for writing the plans would not be sufficient to help complete the plans in a year or two. The phased-in approach allows producers with 100 to 300 animal units up to the year 2005 to meet the requirements. This approach should allow those with expertise in writing plans to assist more producers who need the help. The agency expects that feedlot owners would proceed immediately in developing a comprehensive manure management plan, but at a minimum, would require that a plan be developed whenever a permit is modified for existing facilities, or a the time of permit application for new facilities. At the outside, the agency would expect that the manure management plan for existing facilities be developed or updated when registration comes due the second time for a particular facility (2005).

Item A, subitem 1. Subitem 1 provides for a manure management plan to be completed when application is made for an NPDES or SDS permit. Subitem 1 is needed so that the largest feedlots and those representing pollution hazards must develop plans within the shortest time period, and so that manure management plans are developed prior to construction activities. It is reasonable to require manure management plans from these feedlot owners because feedlot owners with large numbers of animals have the potential to pose grater environmental risks due the amount of manure to be land applied and improper planning; and, because construction activities often result in a need to adjust manure management practices.

Item A, subitem 2. Subitem 2 provides for the preparation of a manure management plan by a feedlot owner when feedlots with 300 or more animal units even when not applying for a permit. The proposed rule establishes the date of October 1, 2002 as the time considered reasonable for feedlot owners with facilities having 300 or more and less than 1000 animal units to complete their plans. The proposed rules allow the development of the plan to coincide with anticipated technical resource availability.

Item A, subitem 3. Subitem 3 provides for feedlot owners having fewer than 300 animal units to complete their manure management plan by October 1, 2005. subitem 3 is reasonable since it allows small to moderate-sized feedlots up to five years to complete the plan after the rules go into effect. More time is needed for completion of these plans since they represent a large fraction of the total number of feedlots in the state and the technical assistance for completion of the plans is limited. While many of these feedlot operators have completed a manure management plan in the past, most of the plans have become outdated or they were not specific enough to be very useful.

Subitem (4) is needed to establish a deadline for when manure management plans must be completed for facility expansions and new facilities which exceed the 100 and 300 animal unit thresholds after the deadline dates established under subitems (2) and (3). This increase in animal units can be achieved by either constructing or just adding animals to an existing site. This subitem is not intended to extend the deadlines established under subitems (2) and (3). This subitem applies to new sites with 100 or more or which expand to 100 or more animal units after the year 2005. This also applies to sites which expand to 300 or more animal units between the year 2002 and 2005 and are not required to have a permit. Where one of these situations apply, the owners will have the one year period to complete the plan. The MPCA proposes to require manure management plans to be completed within one year of exceeding the applicable animal unit threshold. Many facilities will be required under subitem (1) to have the plan prepared by the date that the permit application is submitted to the MPCA or delegated county. This subpart addresses those facilities that would have an animal unit capacity less than 300 animal units after the construction is completed. These construction projects are not required to be regulated by a permit if the construction is completed in accordance with the applicable standards under parts 7020.2000 to 7020.2225. The proposed language provides these facilities one year from the time that animals are placed on the site to complete the plan. This time frame is reasonable because it provides enough time to complete the plan or seek the technical assistance sometimes needed for development of a manure management plan. Often addition of animals are in response to market conditions and allowing a one year period to address these additions is reasonable.

Item B. The agency proposes to require that the manure management plan be at the animal feedlot facility and be available to agency or delegated county. With the estimated required number of manure management plans in Minnesota approaching 20,000, it is unreasonable to expect the agency and delegated counties to review and file each manure management plan each year. However, the plan would be reviewed if for any reason an inspection of the facility was conducted or there were reasons to doubt that proper manure application practices were occurring, or there are high-risk situations for phosphorus transport.

Item B, subitem 1. Subitem 1 is needed to clarify that the only types of permit application requiring an attached manure management plan is an application for an NPDES or SDS permit. A manure management plan is required to be completed for a construction short form, item A, subitem 1; however, in accordance with this subitem, the manure management plan does not have to be submitted to the agency or delegated county for approval. Subitem 1 is reasonable since the agency has limited time to review plans, the provision provides a clear statement of expectations on who needs to submit plans, and the management plan is principally for the benefit of the feedlot owner. The agency or delegated county may request plans from anyone in accordance with item B, subitem 4, if it believes it necessary.

Item B, subitem 2. Under subitem 2, the agency proposes the submittal of a manure management plan to the agency or delegated county when manure intended for application on soils with very high phosphorus levels (75 parts per million [ppm] Bray P1 or 60 parts per million Olsen) in special protection areas and within 300 feet of open tile intakes. These lands are in close proximity to surface waters where phosphorus could be readily transported to lakes and streams. Subitem 2 is needed to ensure that review of management practices occurs when risk to the environment is real due to the proximity of waters and having such elevated phosphorus levels or steep slopes that phosphorus will move with any runoff component. Subitem 2 is reasonable because most soils in Minnesota have less than 75 ppm Bray P1 or less than 60 ppm Olsen test phosphorus, and since manure application on these areas is not expressly prohibited. If the agency or delegated county reviews the site conditions and manure test results and finds that the intended manure application practices will not harm water quality, manure application would be allowed.

Soil phosphorus testing is required in item D, subitem 11. The 75/60 ppm thresholds were selected to be at a level where an increased risk of phosphorus desorbing from soil particles and being washed off the land surface from rain or snowmelt exists. This process is also largely dependent on soil type. The need and reasonableness of this subitem is also referenced in this SONAR for subpart 3.

Item B, subitem 3. The agency proposes a higher soil phosphorus threshold (150 ppm Bray P1 or 120 ppm Olsen) for requiring submittal of a manure management plan when applying manure outside of special protection areas. Subitem 3 is needed to assure that phosphorus will not be transported vertically into ground water or laterally in surface runoff to nearby lakes and streams. With repeated manure applications of high phosphorus manures at nitrogen based rates, soil phosphorus levels can build to levels that can cause pollution problems. Subitem 3 establishes a trigger level, whereby the risk of continued application of manure can be further evaluated. It is reasonable to establish a trigger level since most soils currently have soil phosphorus levels well below these trigger values and exceeding these limits does not necessarily preclude continued manure application. The reviewing authority can consider the sensitivity of the receiving waters to phosphorus, soil type, soil slope and other factors before deciding whether continued manure on such fields cause pollution of waters of the state. The need for plan re-submittal would be determined by the reviewing authority.

Item B, subitem 4. Subitem 4 clarifies that a manure management plan can be requested by the agency or delegated county at any time. Such a standard is reasonable because it maintains the ability of these regulatory bodies to obtain information in evaluating compliance yet allows the feedlot owners to retain control of the plan and does not assume that manure mis-management occurs regularly. Other options or time frames for review would unnecessarily add administrative burdens to the feedlot owner and the regulatory authority.

Item C. The agency proposes that the animal feedlot owner to review and update the manure management plan each year. This requirement clarifies the importance of the manure management plan and the criteria keeping a maintained plan. Making the animal feedlot owner responsible for the review and revision of the plan is consistent with part 7020.2000, subp. 2, that defines the feedlot owner as responsible for ensuring proper land application of manure. The plan review by the feedlot owner without formal regulatory review and approval is reasonable because the process will ensure manure management plans represent current management practices and documents that the owner is complying with the required standards. A manure management plan will be of very little use unless it is reviewed each year and adjusted for changes in manure production, nutrient test results, crop rotations and other farming and manure management practices. However, it would be unreasonable to expect any regulatory authority to review all plans annually and respond in a timely fashion to the feedlot owner to permit implementation.

Item D. The agency proposes to establish a list of information that must be included in the manure management plan. The list in item D ensures that all feedlot owners are aware of the information needed in a manure management plan. The provisions of item D are reasonable because the same information needed by a feedlot owner to make good decisions regarding manure management and ensure that other provisions of Minn. R. ch. 7020 are met. By requiring these items to be included in the plan, the plan can be used as a worksheet for ensuring other provisions of Minn. R. ch. 7020 are fulfilled. The requirements for a manure management plan are not overly prescriptive to all changes and improvements related to manure management planning as new systems are developed. The items were selected to represent elements agreed upon by the task force or FMMAC as being essential for making agronomically- and environmentally-sound manure application rate, timing, and placement decisions.

Item D, subitem 1. The agency proposes to require that the manure management plan include a description of the manure storage/handling system. This requirement provides information on the manure storage or handling system prior to land application, expected quantities of manure, and expected nutrient losses during storage. It is reasonable that the provisions of subitem 1 be included because it provides information needed to complete the other parts of the manure management plan without asking the feedlot owner to spend money since these are known informational items.

The agency requires the manure management plan to state the expected amount of annual manure that will need to be land applied. This information is needed to accurately develop the land application plan. This requirement is currently stated in general terms under part 7020.0500, subp. 2, item A, which requires the permit application to identify the maximum number of animals of each type which can be confined to the animal feedlot. The permit application and manure management plan are submitted to the agency together under the existing rules. For new manure management plans, the amount of annual manure can be calculated from the number of animal units reported on the permit application by using estimates of manure production per animal as reported by the Midwest Plan Service and University of Minnesota. For existing operations, the manure volume can be determined by examination of manure pumping and hauling records from previous years. This provision is not new but rather a codification of current practices.

The agency also proposes under subitem 1 to require identification of the expected annual amount of manure nutrients that will need to be land applied. This information is also needed to accurately develop the land application plan and use the available nutrients most efficiently. Again, subitem 1 is reasonable because it only asks the feedlot owner to document the information needed to safely implement a land application program and obtain the maximum benefit of available nutrients. The amount of nutrients is calculated by multiplying manure volume by the nutrient test results in subpart 2 or by published average manure nutrient concentrations.

Item D, subitem 2. The agency proposes to require that the methods and equipment used to land apply manure described in the manure management plan. The type of application equipment and methods used directly affect the amount of nutrients that will be available for plants. This information is important to the feedlot owner and regulatory authority in wisely utilizing the manure generated at any one feedlot. The information required in subitem 2 is reasonable because it is available information to the feedlot owner, requires only a minimal level of effort to consider impacts on nutrient availability, retains the feedlot owners flexibility in determining how manure will be land applied, and is contained and recommended by existing publications from the Minnesota Extension Service. See Exhibit L-8.

The agency also proposes to require manure application equipment calibration procedures in the manure management plan. Calibration is needed for many spreaders to understand the rate at which the equipment disperses the manure. Without this information, it is easy to over-apply or under-apply the manure compared to the intended rate. Requiring calibration procedures in the plan is reasonable because calibration can be accomplished with little to no money and without consuming much time. Additionally, the value of the entire manure management plan is greatly reduce if there is poor information about the rate at which the equipment applies the manure.

Item D, subitem 3. The agency proposes that the plan include maps on field locations and acreage available for applying manure or aerial photographs of these locations. The information in subitem 3 is needed to document where the manure will be deposited. This requirement is reasonable because it is information that is readily known to the person land applying the manure, must be considered in developing application rates, allows proper planning by watershed groups, and establishes clear expectations of the agency for manure management and recordkeeping. The current rules require that the manure management plan to include the acreage available for manure application, part 7020.0500, subp. 2, item C.

Item D, subitem 4. Subitem 4 requires that a description of manure nutrient test methods be included in the manure management plan. This is reasonable because these methods must meet the criteria under subpart 2, and this documentation will provide an opportunity for evaluation. The agency also proposes to have the testing frequency stated in the report. This is reasonable because the testing is required to be conducted at a minimum frequency proposed under subpart 2, items A and C, but the testing frequency may exceed the minimum requirements. The expected nutrient content of the manure to be applied is also proposed to be required in the plan. This information is needed as a basis for determining proper rates of application. It is reasonable to include this information since it can be obtained through the proposed testing requirement in subpart 2, or, for new operations, can be obtained in Minnesota Extension Service publications. See Exhibit L-8.

Item D, subitem 5. Under subitem 5, the agency proposes that the manure management plan include manure application rates and assumptions used to determine the rates. The application rates provide evidence as to how the feedlot owner developed the final decision for land applying manure once all the information about site, crop and manure conditions have been evaluated. The manure management plan forms the basis for the requirements under subparts 1 and 3 to be met. Subitem 5 requires that the crop nitrogen and phosphorus needs determined under subpart 3, items A and B be included. These needs are matched with available sources of nitrogen and phosphorus. Assumptions used to determine rates of application may also include crop yield goals, soil organic matter levels, and nitrogen from previous year's legumes. Again, subitem 5 is only documenting the process used to make a decision and not requiring new information.

Item D, subitem 6. The agency proposes to require the feedlot owner to plan the total manure nitrogen and phosphorus rates to be applied on each field and for each crop in the rotation. The information proposed in subitem 6 is needed so that the producer and agency know the amount of nutrients applied and at what application rate as determined under subitem 5. This is reasonable since this information can be readily calculated and is essential for applying the manure at rates meeting the nitrogen and phosphorus rate standards in subparts 3 and 6. It is also important for the producers to know this information so that commercial fertilizer is not applied excessively in addition to the manure nutrients.

Item D, subitem 7. In subitem 7, the agency proposes that the manure management plan identify what fraction of the nutrients are expected to become available to crops during the first two years of application. The availability of nutrients to crops is needed to permit the feedlot owner to determine the maximum manure application rate for compliance with standards set in subparts 3 and 6 for both growing seasons following application. This is reasonable since the information can be readily obtained from Minnesota Extension Service publications. See Exhibit L-8.

Item D, subitem 8. Subitem 8 contains the requirement that the feedlot owner include in the manure management plan the months when the manure is expected to be land applied. Consideration of the time for land application ensures that the feedlot owner utilize manure application practices consistent with winter application setbacks in subpart 6, item A, and other planning considerations proposed in subpart 4, item D, subitems 10 and 14. The provisions of subitem 8 are reasonable since producers generally do know and need to know when they will be applying manure. To meet the requirements of subitem 8, the feedlot owner need no extra assistance or expend costs, yet has the information readily available to support decisions made regarding manure application rates.

Item D, subitem 9. Subpart 1, item A, subitem 2, prohibits the land application of manure polluting of waters of the state. The agency proposes the manure management plan to describe the protective measures intended to minimize the risk of off-field manure transport when land applying manure in areas that may create a pollution problem. Such areas include floodplains, soil within 300 feet of public waters, intermittent streams, uncultivated wetlands, surface tile intakes, sinkholes without constructed diversions, drainage ditches, and soils with less than three feet above limestone bedrock. The proposed requirement is reasonable because it only serves document decisions made to comply with the requirement under subpart 1. The feedlot owner is not required to develop new information.

Minimum requirements are proposed in subparts 6, 7 and 8 for protection of lakes, streams, public waters, wetlands, intermittent streams, un-bermed drainage ditches, open tile intakes, and sinkholes. However, these minimum requirements may not provide enough protection to meet the proposed requirements in subpart 1, item A, subitem 2. Specific minimum requirements are not established elsewhere in the proposed rule for manure application in floodplains, around wetlands that are not classified as public waters wetlands, and areas with shallow soil above fractured limestone bedrock. Subitem 9 is needed to ensure that adequate measures are considered to protect water quality in these potentially vulnerable settings. Subitem 9 is reasonable because it allows feedlot owners the flexibility to choose management options that are most conducive to the farm operation and the environmental sensitivity of the area.

The agency proposes to expand what the term, protective measures, means when developing the manure management plan. This additional clarification is reasonable because it does not limit the options for trying to prevent manure runoff from contaminating waters, but does provide some management components that could be evaluated for addressing such problems.

Item D, subitem 10. Under subitem 10, the agency proposes that information regarding the application of manure onto frozen or snow-covered soil to be included in the manure management plan. These manure application conditions present unique hazards to Minnesota and this requirement is needed to ensure that these hazards are evaluated and managed appropriately. The following information provides the background regarding proposed rule considerations concerning winter application of manure.

The August 1995 MPCA report entitled “Basis and Justification for Manure Application Guidelines,” pages 29 to 32, describe the increased risk of water quality impacts with winter application. See Exhibit L-2, pages 29 to 32. Existing research shows some increased potential for phosphorus, bacteria and oxygen demanding substances to be transported on frozen soils compared to non-frozen soils. However, the increased risk from solid manure applied to frozen soil was not found to be very great due to the mulching effect of the solids and bedding in the manure, and no research was identified describing the effects of liquid manure application during winter conditions. Phosphorus runoff from winter application was only slightly higher in the solid manure application plot compared to control plots with no manure. In general, the research comparing contaminant transport from manure applied at different times of the year is limited.

Pathogen survival is typically greatest during the wintertime. Since manure cannot be incorporated into frozen soils, pathogens are left at the surface where they are more likely to be transported to waters in snowmelt runoff. Water quality risks associated with winter application of manure were believed to be great enough to prohibit winter application in special protection areas (subpart 6, item A). See Exhibit L-2, pages 29 to 32 and Exhibit A-1.

Task force opinions and recommendations were more varied regarding winter application restrictions to sloping land outside of the 300 foot special protection area zones and land within 300 feet of open tile intakes (see discussion under subpart 6).

Reports comparing runoff of winter manure application from varying slopes were not found in the literature search. Water and sediment runoff potential is greater for steeper-sloped land with other factors being equal. If manure runs off from steeply sloping land, then there is a greater risk of contaminant transport to surface water, even if the surface water is more than 300 feet from the application site. There is also a risk that pooled areas of manure at the toe of the slope following snowmelt runoff would increase risks of ground water contamination. For these reasons, the following rule language was initially proposed: "Manure must not be applied onto frozen or snow-covered land with slopes greater than six percent, except for solid manure applied during periods with no snowmelt onto land with NRCS or MPCA approved conservation practices."

Several concerns were identified with the above proposed rule language.

- Some argued that solid manure does not contain that much more solids than liquid manure, and therefore there should not be different requirements for solid and liquid manure. Very little research has been conducted on liquid manure runoff applied to frozen soils.
- The MPCA, NRCS, and others identified problems in determining what was an approved conservation plan and the administrative difficulties associated with approving the conservation plans.
- Many farms in southeastern Minnesota and parts of central Minnesota reportedly do not have enough land with slopes less than six percent so that they can avoid winter application to such slopes. Information from the NRCS database (NRI) on soil slopes showed that throughout the entire state, about 93 percent of cropland acres have soils with slopes less than six percent. However, the land around Becker, Hubbard, Beltrami, Itasca, Clearwater and Mahnomen counties had 13 percent of its cropland with slopes exceeding six percent. The region composed mostly of Houston, Fillmore, Winona, Olmsted, Wabasha and Goodhue counties had 34 percent of cropland with slopes exceeding six percent.
- If there is an early freeze-up, farmers who normally plan to fall-apply would not be able to apply manure onto their land with slopes exceeding six percent. Early freeze-ups are unpredictable and common. Minnesota has a shorter growing season than most states and there is limited time in the fall to apply manure between the time of crop removal and soil freezing.
- Winter application to a slopes less than six percent can also create problems for water quality under certain conditions. The rules should not imply that all winter application to slopes less than six percent is environmentally acceptable.

It was suggested that for farming situations where winter slope restrictions for liquid and semisolid manure could not be reasonably met, the producer could obtain authorization from the agency, provided that this practice is conducted on land where there is minimal chance of runoff to surface waters or sinkholes. This recommendation was unacceptable to the agency because it is not administratively feasible.

In response to the above noted concerns, the proposed rule language was modified to require a description of protective measures to be included in the manure management plan for winter application. This final approach of requiring specific information in the manure management plan related to winter application is reasonable because it creates a heightened awareness of water quality concerns associated with winter application on sloping land, but yet allows the feedlot owner flexibility regarding how to minimize potential risks to water quality. The agency proposes to require basic information regarding the fields that will have the winter and slope conditions described in the subitem to be in the manure management plan. It is reasonable to clearly identify areas of special concern in the proposed rules so that expectations are known by all feedlot owners. The agency proposes to require the methods that will be used to minimize the risk of manure contaminated runoff to be described in the plan. See the discussion under item D, subitem 9.

Item D, subitem 11. In subitem 11, the agency proposes to require that soil phosphorus tests be conducted as part of the manure management planning process. Depending on the soil pH, the tests are to be a Bray P1 or Olsen test. These test methods are the two commonly-accepted tests for soil phosphorus in Minnesota. This information is useful to identify the land that needs additional manure applications to supply crop phosphorus needs or should be used carefully as an application site depending on the application rate. The soil phosphorus testing is needed to comply with subpart 4, item B, subitems 2 and 3; subpart 4, item D, subitem 12, and subpart 6, item B, subitem 2. The need for the proposed soil phosphorus testing is further described in this SONAR for subpart 3. Subitem 11 is reasonable since it provides information useful for soil nutrient management and to check compliance with other parts of the rules. Additionally, the costs of sampling need only be incurred once every four years. The soil phosphorus testing will create further awareness among feedlot owners regarding the fields will benefit most from manure applications and those most at risk from over application based on nitrogen application rates.

Item D, subitem 12. Under subitem 12, the agency proposes that the manure management plan include a description of how phosphorus from manure will be managed to minimize phosphorus transport to surface waters and prevent the soil phosphorus building to the levels stated in subpart 4, item A, subitems 2 and 3. This information is needed to address the concerns described earlier in this SONAR under subpart 3 concerning phosphorus rate restrictions outside of special protection areas and to prevent pollution of surface waters as a result of manure application. This requirement is reasonable since it allows the feedlot owner flexibility to implement phosphorus application provisions based on site-specific soils, residue management, slopes, proximity to waters, manure nutrients, crop rotations and hydrologic conditions.

The soil phosphorus levels triggering this additional level of planning are listed in subpart 4, item B, subitems 2 and 3. Research on phosphorus transport from agricultural lands is progressing at a rapid rate. Therefore, the proposed rules in subitem 12 allow the flexibility to adjust the soil phosphorus thresholds, which trigger additional planning to ensure that manure application does not cause pollution of waters of the state. It is reasonable to adjust the threshold numbers since these thresholds are only used to trigger increased planning levels; the changes must be published in the state register; and the rules will allow conformance with scientific knowledge over time.

Item D, subitem 13. Subitem 13 contains the requirement to establish nitrate soil testing in the manure management plan where such testing is recommended by the University of Minnesota Extension Service and other technical assistance experts. Nitrate testing in the soil is needed to meet the requirements under subpart 1 and subpart 3. Soil nitrate testing indicate any necessary adjustments needed in the manure application rates to minimize excess nitrate movement to ground water. This requirement is reasonable since it only requires testing when the residual soil nitrate may be high due to past land use practices, fertilizer application rates, types of manure land applied and related information. Most feedlot owners would not be required to meet this standard.

The University of Minnesota has conducted research to show situations when the soil nitrate test is environmentally beneficial for making adjustments to nitrogen application rates. This testing is not universally recommended. The situations where the soil nitrate test is recommended and the procedures for taking these samples are described in Minnesota Extension Service publications. See Exhibit L-12. These recommended procedures will be refined as new research becomes available.

Item D, subitem 14. The agency proposes in subitem 14 to require in a manure management plan the type of cover crop to be used when manure is applied in June, July, or August on fields that have been harvested and will not have active growing crops for the remainder of the growing season. Manure nitrogen that is applied to fields during summer months can be lost to ground water before a crop can remove this soil nitrogen. Therefore, establishment of a cover crop is needed so that the crop can use the manure nitrogen before it will be lost in the subsurface waters. With manure applications during the fall months, there is a reduced fraction of nitrogen that will be transported to ground water. It is reasonable to require this provision be met to ensure the establishment of a cover crop is not prohibitively costly and can have additional benefits, including reduced soil erosion.

Item E. When the manure ownership is transferred for the purposes of land application to fields not owned or leased by the feedlot owner, the agency proposes that the feedlot owner include in a manure management plan only those requirements in item D, subitems 1, 2, 4, 8, 9, 12, 13 and 14. These types of planning provisions can be made independent of knowledge of the specific fields where the manure is to be applied. The subitems of the manure management plan exempted for the producer in item E are those items that require specific knowledge of the fields intended for use in the land application program. These exempted items are required to be completed by the receiver of the transferred manure in accordance with subpart 1, item D. Please also see SONAR associated with subpart 1, item D.

Item E is needed so that the feedlot owner understands how much manure and nutrients will be hauled so proper arrangements can be made to have the manure land applied. This requirement is reasonable because the feedlot owner whose facility is producing the manure to be transferred to others will often not have knowledge regarding how the purchased manure will be used on land application sites and the crop-specific information needed for a comprehensive manure management plan.

A common practice, particularly for the poultry industry, is for feedlots to transfer ownership of their manure to either commercial manure applicators or producers who will then apply the manure onto land that is not owned by the feedlot owner. Such facilities that produce the manure will have estimates of the manure volume to be generated and the nutrient content of manure. However, they will not know the soil and crop characteristics for the land that the manure gets applied. For this reason they will be unable to develop a comprehensive manure management plan meeting all requirements in item D. While the producers of manure to be transferred do not retain all control of manure after transfer, the producer may make conditions of transfer contingent on the manure receiver following certain measures to protect surface waters from manure runoff or high phosphorus runoff resulting from manure application.

Manure application benefits soil in many ways. Manure adds macro- and micro-nutrients needed for plant growth, increases soil organic matter in low organic matter soils, and increases the soil's ability to hold water and resist compaction and crusting in many soils. Manure is most likely to be applied at proper rates and used for its soil enhancing properties when it can be viewed as a desirable and valuable resource rather than a waste. As additional restrictions are placed on application of manure, it is possible that the perceived value of this resource diminishes. If regulations are too tight, then non-livestock farmers will have less desire for manure and it then may be more likely to be over-applied on the land owned by the producers. It is for these reasons that the Land Application of Manure Task Force recommended to keep the rules from being overly burdensome for receivers of transferred manure.

Subpart 5. In subpart 5, the agency proposes that records of manure application practices be maintained. Items A and B relate to recordkeeping requirements for those who manage the cropland where manure is applied. However the requirements in items A and B only apply when the manure being applied originates from a feedlot with more than 100 animal units. Item C describes the proposed recordkeeping requirements for feedlot owners who do not apply manure onto land they manage. Item D includes recordkeeping requirements for commercial manure applicators spreading manure onto land not owned or leased by the feedlot owner.

Item A. The agency proposes to require that the manager of the cropland where manure is applied keep records of the land application information. Records of manure application practices are needed for three primary reasons. First, records enable owners to accurately account for nutrient additions to their fields so that excess fertilizer or additional manure is not added to fields that have already received manure. Second, records enable feedlot owners to better plan for manure application during future years. Third, records enable a feedlot owner to verify that they are complying with the requirements under Minn. R. ch. 7020 and enable MPCA or delegated county to check compliance with rules governing manure application.

The amount of time it takes to keep the records depends on the size of the farm and complexities of crop rotation and manure management. More time will be required for larger farms with multiple fields of varying crop types. Records are only required to be kept for people receiving manure from 100 animal units so as to be generally consistent with the animal unit threshold for requiring a manure management plan. The 100 animal unit threshold for record keeping is intended to include manure that is either owned by the feedlot facility, has transferred ownership of manure, or a combination of the two. Feedlots with less than 100 animal units increasingly represent a relatively small fraction of manure generated in the state, estimated by the agency to be less than 25 percent.

Item A, subitems 1 and 2. These subitems define the length of period feedlot owners are required to keep records. Subitem 1 proposes to require records to be kept for six years for fields within 300 feet of public waters, intermittent streams, and drainage ditches. Six years is needed near surface waters to enable the feedlot owner to ensure that phosphorus rates over a six-year period are not exceeding crop phosphorus removal as required in subpart 6, item B, subitem 2. Subitem 2 proposes that records be kept for three years for fields other than as being in special protection areas. Three years of records are needed in other areas to keep track of nutrient carry-over from the previous two-years of manure application and legume plowdown. Additionally, three years is consistent with recordkeeping provisions found in other agency rules. The subitems also require that should enforcement action be initiated all records must be maintained during the duration of the enforcement proceedings.

Item B. This item outlines the information the agency proposes for the maintaining of the land application records. The proposed requirements are reasonable because the type of information required for records is only that information necessary to enable the feedlot owner to track nutrient rates and compliance with the requirements in part 7020.2225. Many of the requirements for recordkeeping are similar to or identical to manure management plan requirements in subpart 5, item E. The records identify actual manure management activities. The manure management plan differs in that it only identifies specific plans for the manure prior to application. The manure management plan and records can be different since unforeseen circumstances will often prevent manure application practices. The agency intends that enforcement be completed on failure to protect the environment and thus, it is reasonable that information be maintained to allow such a determination.

Recordkeeping requirements in other parts of Minn. R. ch. 7020 that relate to the requirements of part 7020.2225, subp. 5, item B, are listed in Table 6.

Table 6. Recordkeeping Requirements for Manure Application and Manure Management Plans.

Record content requirements under part 7020.2225, subp. 5, item B	Related part 7020.2225 requirement and compliance concerns
Subitem 1: Field locations and cropland acreage where manure is applied.	Subpart 4, item D, subitem 3 and subparts 6, 7, and 8: Field locations and acreage available for applying manure.
Subitem 2: Volume or tonnage of manure applied on each field.	Subpart 2 and subp. 4, item D, subitem 6: Total manure nitrogen and phosphorus rates to be applied on each field and for each crop in rotation.

Record content requirements under part 7020.2225, subp. 5, item B	Related part 7020.2225 requirement and compliance concerns
Subitem 3: Manure test nitrogen and phosphorus content, as required by subpart 2.	Subpart 2: Manure nutrient testing requirements and subpart 3 – nutrient application rate standards.
Subitem 4: Dates of application.	Subpart 4, item D, subitem 8: Expected months of application, and subparts 6 and 7.
Subitem 5: Dates of manure incorporation when incorporating within 10 days.	Subpart 3, item A; subpart 6, item B: Also needed to estimate the fraction of total nitrogen which will become available to the crop.
Subitem 6: Expected plant-available amounts of nitrogen and phosphorus released from manure and commercial fertilizers on each field where manure is applied.	Subpart 3 and subpart 7.
Subitem 7: A description of deviations from the manure management plan including documentation of the justification for any remedial nitrogen applications which exceed the nitrogen rate standard in subpart 3.	This is needed to make it clear that deviations from the manure management plan are allowed and to aid in compliance checks when deviations occur.
Subitem 8: Soil nutrient test results.	Subpart 4, item D, subitems 11 and 13, and subpart 6, item B.

Together, the manure management plan and the land application records provide a complete picture of application practices. As changes in weather and farm prices change, the actual manure application practices may change from what was intended and stated in the manure management plan. The closer to the time of application that the manure management plan is written or updated, the greater chance that the manure management plan and the records coincide. A feedlot owner is allowed to deviate from the manure management plan provided the deviations do not result in a violation of this part or permit conditions and these changes are recorded as required under subitem 7.

Due to the numerous items proposed to be required in the manure management plan and the detailed records which will need to be kept, the Minnesota Extension Service, in cooperation with the MPCA and other agencies, has obtained a federal grant to provide training to feedlot owners and those assisting feedlot owners. See Exhibit L-16. The training will describe how to develop a manure management plan and how to keep records in accordance with the proposed rules.

Item C. This item outlines the recordkeeping responsibilities for the feedlot owner when manure is spread on sites <u>not</u> owned or leased by the feedlot owner. Records are needed when livestock producers sell or give away their manure to others so that the agency and delegated counties can track compliance with part 7020.2225. These requirements are reasonable since the information in the records is either easily known by the facility producing the manure, or will be supplied by the receiver of the manure.

Item C, subitem 1. In subitem 1, the agency proposes that the feedlot owner record the volumes or weight of manure delivered; the nutrient content of the manure delivered; the name and address of the receiver of the manure; the location where the manure was applied; and the rate of application. This information is needed for understanding the fate of the generated manure, and so that the livestock or poultry feedlot owner generating the manure can track application practices and make any necessary adjustments concerning where or to whom the manure goes. Subitem 1 is reasonable since the volume or tonnage of manure, nutrient content, and receiver of the manure is easily known by the producer. The location and rate of application will be mailed to the livestock producer by commercial applicators per subitem 2 or can be otherwise tracked by the feedlot facility.

There are, however, situations such that the location where the manure is applied and the rate of application can not be tracked. This can occur when manure stockpiles or liquid manure is mixed or composted together with manure from other sources. This information must be maintained for three years. The length of record retention is reasonable because it generally is consistent with the retention schedule proposed under Item A, subitem 2 and other agency rules.

Item C, subitem 2. Commercial applicators often take manure from the livestock facility and apply it onto cropland for a fee. This practice is particularly common with poultry manure. Commercial applicator records are necessary to track compliance from the livestock facility to the receiving field. Subitem 2 reflects the need to understand how manure is being managed by commercial applicators. If the manure is purchased by a commercial applicator, the livestock facility will typically only keep records of the commercial applicator name and not the cropland to which the manure is applied. Even more important it the lack of knowledge a feedlot owner may have on the final application site.

The agency proposes to require commercial applicators to keep records in accordance with subitem 1, and to submit a copy of the records within 60 days to the owner of the animal feedlot, which produced the manure. The information is needed to track compliance with part 7020.2225 when ownership of manure is transferred. It is reasonable because the commercial applicator will easily know the information if they are keeping detailed records of stockpiling practices, and since the records can be mailed to the feedlot facility at minimal cost.

Subpart 6. The agency proposes to establish requirements for manure application requirements for land within special protection areas.

Item A. The agency proposes that manure being spread onto frozen or snow-covered ground not be applied any closer than 300 feet from surface waters and channels to surface waters, also defined as special protection areas. A winter setback from surface waters is needed to prevent excessive amounts of nutrients, pathogens and oxygen demanding substances to move in snowmelt to surface waters. The need was further discussed in association with subpart 4, item D, subitem 10. This requirement is reasonable since feedlot owners without adequate manure storage capacity to make it through the winter will have two options: avoid applying manure in the winter to entire fields which are adjacent to surface waters; and, avoid applying manure in the 300-foot setback zone from surface waters during winter months and fertilize this area with manure or commercial fertilizer during the fall or spring months. These options were deemed reasonable by the land application of manure task force because winter application to land more than 300 feet from surface waters is still permitted; and there will usually be time to apply manure to the 300-foot corridor areas before or after soil freezing and snow cover.

Reasons for choosing the distance of 300 feet are described in “Basis and Justification for the Minnesota Land Application of Manure Guidelines” dated July 1995. See Exhibit L-2, pages 28 and 29.

Item B. The agency proposes to require pollution prevention measures when applying manure during non-winter months to land within 300 feet of surface waters and channels leading to surface waters. It is proposed that two different options be given to feedlot owners. The options allow the feedlot owner to maintain a permanent vegetative buffer along the water or waterway; or to place the manure below the soil surface; apply at a rate and frequency that prevents soil phosphorus from accumulating over time; and maintain a 25-foot setback. The need for non-winter manure application restrictions on land within 300 feet from surface waters and channels, is described in “Basis and Justification for the Minnesota Land Application of Manure Guidelines” dated July 1995. See Exhibit L-2, pages 28 and 29.

The primary environmental concerns with near surface water application relate to storm events and runoff following surface application of manure, and soil phosphorus build-up caused by repeated application of manure at rates based solely on crop nitrogen needs/removal. Storm events can carry phosphorus, ammonia, pathogens and biological oxygen demand to nearby receiving waters. The amount of phosphorus in the surface layer of soil correlates with the concentration of dissolved phosphorus in runoff. Phosphorus will also move to waters while being bound to soil particles as these particles are eroded. Phosphorus enriched sediment is most likely to be transported to waters when located in close proximity to waters and channels to waters.

There is more than one way to minimize environmental risk when applying manure to land near surface waters. One way is to treat the runoff waters with vegetation before the water discharges into a lake, stream, or channel to a lake or stream. Another way is to prevent contaminant transport by placing the manure below the soil surface prior to any rainfall. Preventing soil phosphorus accumulation will further reduce the environmental risks associated with phosphorus transport. The proposed rules are reasonable since they allow greater flexibility for feedlot owner and an adequate degree of environmental protection.

Item B, subitem 1. Vegetated buffers have been shown in numerous studies to be effective treatment options in reducing runoff contaminants such as nutrients, BOD and bacteria. See Exhibit L-2, pages 21 and 22. The primary mechanisms for contaminant removal include a reduction in runoff volume by increased infiltration; a decrease in runoff velocity resulting in sedimentation of contaminants that are adsorbed to particulate matter; and an increased adsorption of pollutants by soil particles under the influence of a lower ionic concentration regime than found on the manure application site. A vegetated buffer will not remove all contaminants and the degree of contaminant removal depends on such variables as the soil type, slope, manure type, and buffer width. A buffer width of 50 to 100 feet will provide significant treatment of contaminants and does not take large areas of land out of agricultural production.

In all cases, the proposed rules provide farmers with a choice of avoiding the other manure application restrictions (subitem 2) if they maintain the 50 to 100 foot wide strip of permanent vegetation along the water or channel. In some areas, well-established buffers already exist. Where buffers do not already exist, producers would have the option of taking some land out of production. A 100-foot wide vegetative buffer amounts to less than two and one-half acres of a 40-acre field if one side of the field abuts the water. If the stream splits the 40-acre field then nearly five acres would be affected with a 100 foot wide strip. If this is not feasible, then the agency proposes that feedlot owner would have the choice of meeting the requirements under subitem 2.

The required buffer width is greater (100 feet) for lakes and streams compared to other waters and channels protected within Special Protection Areas. The additional 50-foot safety measure was added to lakes and perennial streams to provide greater assurance that the waters which are more sensitive to phosphorus and other contaminant additions receive greater protection. Also, the Land Application of Manure Task Force considered 100 feet of buffer along the numerous wetlands and intermittent streams to be unreasonable, since it would require taking too much land out of production.

Item B, subitem 2. Feedlot owners, who choose not to maintain a 50- to 100-foot wide vegetated buffer along waters and waterways, yet would like to apply manure onto fields adjacent to these waters and waterways would still be able to apply the manure as long as they limit rates over a six-year period to equal phosphorus removal (when soil phosphorus concentrations exceed 21 ppm Bray P1); the manure is placed below the soil surface; and manure is applied no closer than 25 feet from the water or channel in the special protection areas.

Item B, subitem 2, unit a. A 25-foot setback, unit a, from lakes, streams and other waters associated with special protection areas is needed to ensure that manure does not enter the water or waterway during the process of applying the manure, or via shallow ground water which is commonly found in this zone so close to surface waters. The 25-foot setback was considered reasonable by the task force and the agency because the amount of land that would be taken out of production would be very small; or if the feedlot owner keeps the land in crop production, the feedlot owner could make one pass with commercial fertilizer along these waterways in order to provide the needed nutrients.

Item B, subitem 2, units b and c. Immediate incorporation and a phosphorus based rate or frequency of application greatly reduces the risk of manure transport to surface waters and minimizes the risks associated with soil phosphorus in runoff from the application site. These options were generally deemed reasonable by the Land Application of Manure Task Force since they are not excessively costly for the feedlot owner; they greatly reduce the environmental concerns associated with manure application near waters; and they are not overly complex.

The primary additional farmer costs associated with this option is the supplemental commercial nitrogen fertilizer usually needed to be applied during some years within the 300-foot special protection zone. Another possible cost would be to obtain equipment needed to inject or incorporate the manure. The primary environmental concern expressed by the Land Application of Manure Task Force under the option in subitem 2 is that manure can still be applied to soils having a pre-existing elevated soil phosphorus levels.

Many soils have naturally high soil phosphorus. Under the proposed rules, farmers with high phosphorus soils would need to either apply manure to the zones along the 300-foot strip of land during fewer years and would need to add supplemental commercial nitrogen fertilizers during some years, or maintain the permanent vegetated buffer. Additions of phosphorus at a phosphorus-based rate will not increase the environmental risk. But for soils already having high phosphorus soils, these soils would continue to be fertilized.

Research shows that both erosion rates and soil P levels are important variables affecting risk to water quality degradation, and both variables are considered in the voluntary MPCA manure application guidelines for land within 300 feet of surface waters. See Exhibits L-1 and L-17. However, erosion is not factored into the required setback rule restrictions. A goal of the task force was to develop rules that were not overly complex in anticipation that they would likely be more understood and followed. Adding soil erosion rates as another variable into the rules would significantly increase the complexity of the rules. Erosion rate estimates are calculated from numerous soil and crop residue factors. Feedlot owners often do not know the erosion rate estimates for their fields, and many producers only know whether or not they have more or less than five tons of soil erosion per acre per year. The added environmental protection by factoring erosion rates to the rules was generally not believed to outweigh the disadvantages of added rule complexity.

However, if manure is to be applied to soils with soil phosphorus levels exceeding 75 ppm (Bray P1) or 60 ppm (Olsen) in the special protection areas, then the manure management plan would need to be reviewed by the agency or delegated county, in accordance with subpart 4, Item B. During review of the manure management plan, the agency or delegated county can review soil slope, erosion rates, and other factors affecting phosphorus transport.

Another concern expressed by some task force members was that the requirements under Item B do not pertain to most wetlands less than 10 acres. Wetlands are protected in several ways throughout the proposed rules, as listed below:

- Application of manure is prohibited to enter any uncultivated wetland during the process of applying the manure, as already described in rule subpart 1, item A;
- Manure management plans must describe protective measures to minimize the risk of off-field manure transport when applying manure within 300 feet of all uncultivated wetlands in subpart 4, Item D, subitem 9;
- There is a 300 foot winter application setback from all public waters wetlands, including all type 3, 4 and 5 wetlands greater than 10 acres (in subpart 5, item A). If winter application within 300 feet of other wetlands is to occur, the manure management plan

must indicate the soil and water conservation measures, timing of application, application locations and other manure management practices that will minimize the risk of off-field manure transport in subpart 4, item D, subitem 10; and

- In addition, application of manure during non-winter conditions within 300 feet of public waters wetlands is subject to the restrictions listed in this subpart.

All uncultivated wetlands are provided with some degree of protection throughout these rules. Public water wetlands are protected from filling and drainage through other laws. The proposed rules are reasonable since they will not add to management difficulties for feedlot owners with these smaller wetlands management challenges that could contribute to further wetland loss.

Item C. The agency under item C proposes to prohibit liquid manure from being dispensed from spray irrigation equipment outside of special protection areas. This proposed rule is needed since application of manure through irrigation systems increases risk of contaminant transport in wind drift. The 300-foot setback is proposed to reduce the risk of phosphorus and pathogen transport to the water body via the air or from surface runoff. The proposed rule is reasonable since irrigation equipment is rarely used in Minnesota for manure application and thus, the proposed restriction will not affect many producers. Also, in most areas there is adequate land away from the 300-foot setback zones to allow for spray irrigation activities. The spray distance of 50 feet is put into the proposed rules to clarify that spraying the manure onto the soil from behind a truck or tractor is still allowed.

Subpart 7. The proposed rules require manure to be injected or immediately incorporated within 300 feet of open tile intakes so that it is no longer readily available for transport to surface waters. The 300-foot distance was selected to coincide with the 300-foot distance used to define special protection areas. Rules protecting manure from runoff into open tile inlets is needed since open tile inlets are direct conduits of field runoff waters to drainage ditches or streams. Open tile intakes are also typically located on land that has low permeability and fewer soil conservation practices. Manure application concerns near open tile intakes are heightened during winter months and other situations when manure can not be injected or immediately incorporated, therefore leaving the manure more vulnerable for surface runoff into these conduits to surface waters.

The Land Application of Manure Task Force had a difficult time determining a reasonable approach to minimize manure runoff into these drains. The proposal to require immediate incorporation or injection within 300 feet of open tile inlets met much resistance with the Land Application of Manure Task Force. The following concerns were raised:

- Equipment does not allow injection or immediate incorporation during frozen soil conditions. A 300-foot winter setback would leave about seven acres around each surface tile inlet with no manure/nutrients. Many fields have several surface tile inlets. The farmer would either need to go back on all of these seven-acre plots and apply commercial fertilizer; apply manure during non-winter months; or not apply nutrients to these areas. Either a decrease in crop yield would occur, or farmers must invest additional time and expense to go back onto the fields and fertilize these areas during non-winter months.

- On tile drained lands, spring application is not feasible due to wet soils and compaction problems. In the summer and early fall the crop is in the ground. This leaves only mid to late fall and winter for spreading. With an early freeze, a winter application restriction around tile intakes would leave only a very narrow window of time for application in these fields. Many farms have most of their fields with intakes, and setback rules would require a patchwork of spreading around the intakes in the earliest part of the fall.
- Manure application is not the only problem with open tile intakes. Commercial fertilizers, sediment, and pesticides are also transported into open tile intakes. Alternative drainage methods need to be investigated. Manure runoff may contribute to the problem, but the real problem is the technology devised to drain the fields. Ongoing and proposed research may lead to alternative technologies.
- The question was raised about whether a strict setback of 25 to 50 feet could be an alternative to the 300-foot immediate incorporation zone. It was agreed by most task force members that small setbacks do not provide a lot more protection than no setback because the water often becomes ponded in the area around the open tile intake.

As a compromise to the conflict between need and reasonableness, the task force and FMMAC suggested the immediate incorporation restriction be phased in over time so that by a certain date manure must be immediately incorporated or injected if applied within 300 feet of an open tile intake. Until that time, open tile intakes would not be ignored since the manure management plans must include a description of how manure transport to open tile intakes will be minimized. In addition, the rules leave open the possibility for other options. There is ongoing research evaluating the effects and alternatives of open tile intakes. If other best management practices are developed to minimize pollutant transport from manure application around open tile intakes, and the MPCA approves these techniques, then producers may instead adopt these approved alternatives.

Item A. The agency proposes to require all liquid manure applied within 300 feet of open tile intakes to be injected or incorporated within 24 hours of application, and that this requirement will not be phased in but will become effective from the date these rules become effective. This is needed to prevent liquid manure from flowing into open tile intakes during application or in rain events following application. This is reasonable since liquid manure is usually injected or immediately incorporated throughout the state.

Item B. The agency proposes to allow for approximately four years after the effective date of the rules (October 1, 2004) before non-liquid types of manure would be required to be immediately incorporated within 300 feet of open tile intakes. This is needed to prevent bacteria, phosphorus, and other contaminants from entering surface waters via tile intakes. It is reasonable to allow this grace period for solid manure since it can be more challenging to manage manure for immediate incorporation of solid manure compared to liquid manure, and since solid manure presents a slightly reduced risk of contaminant transport into tile intakes.

Subpart 8. This subpart contains the agency's proposed language with regard to application near sinkholes, mines, quarries and wells.

Item A. A 50-foot setback is proposed between manure application sites and active or inactive water supply wells, sinkholes, mines and quarries. This is needed to reduce the chance of pathogen migration to well water and other ground water. The proposed setback is reasonable since a 50-foot setback is the distance Minnesota Department of Health requires between wells and many common potential contaminants, including animal holding areas (Minn. R. ch. 4725).

A member of the task force suggested that the manure application setback distance be increased for public water supply wells. This issue was discussed with staff from the wellhead protection program at the Minnesota Department of Health. The increased setback for public water supply wells was not added into the proposed rule because each city will be developing wellhead protection plans to protect their wellhead area, and the needed setback distance will vary greatly among wells. In many situations, a 50-foot setback would be more than enough to protect a public water supply well, and in other situations several hundred feet may be needed. Each city will work to protect their own well based on the individual characteristics of the well construction, soils, geology, and land uses.

Item B. A 50-foot setback distance was not considered adequate to protect manure runoff from sinkholes when manure is surface applied (without immediate incorporation) onto land which slopes into the sinkhole since sinkholes are often in low lying areas where surface runoff concentrates. The proposed distance for which manure needs to be incorporated up slope of a sinkhole was increased to 300 feet, which coincides with the 300-foot distance associated with manure application near surface waters proposed under subpart 6, item B, subitem 2, unit b.

V. CONSIDERATION OF ECONOMIC FACTORS

Minnesota’s farm economy was in a state of transition in 1999 when these rules were being drafted. The Minnesota legislature and the Governor’s office were very sensitive towards the needs of the farm community during this period of transition. The Minnesota Pollution Control Agency strove to incorporate the most economically sensitive approach to protect Minnesota’s, air, and water from the pollution caused by livestock production. The rule has also undergone intense review by the Feedlot Manure Management Advisory Committee (FMMAC), a team of agribusiness people, University experts, environmentalists, and local government officials, to arrive at the best possible approach for regulating Minnesota’s livestock industry.

A. Classes of Persons Affected by the Proposed Rule

Minnesota Statutes Section 14.131, Minnesota Statute section 115.43, subdivision 1, and Minnesota statute 116.07 subdivision 6 require the MPCA to address the economic impacts of the proposed rules. One of these requirements is to estimate the probable costs of complying with the proposed rule. These costs are summarized in this section. In addition, section 14.131 requires a description of the classes of persons who probably will be affected by the proposed rule, including classes that will bear the costs of the proposed rule and classes that will benefit from the proposed rule.

In general, the classes of persons that will most likely be affected by the proposed rules include owners and operators of animal feedlots and manure storage areas; persons involved in the storage, transportation, disposal and utilization of manure, which includes commercial manure applicators; those interested in management of domesticated animals or related facilities; delegated counties, counties interested in applying for delegation to implement a feedlot program; and those interested in Minnesota's water resources.

The MPCA broke these general groups into four categories of classes for the economic impact analysis purposes. The four categories discussed in more detail below include:

- Owners and operators of animal feedlots, manure storage areas and pastures;
- Delegated counties;
- Persons concerned about environmental quality; and
- State government.

Owners and Operators of Livestock Facilities

This group is evaluated by animal type sector (dairy, beef, swine, and poultry) and animal unit capacity category (10 or 50 to less than 300 animal units, 300 to less than 1,000 animal units and 1,000 and more animal units) as appropriate to the rule parts being discussed in the overall economic impact analysis. In general, this class will be affected by the proposed rules. This class will experience a slight increase in costs under the rules as proposed compared to the requirements under the existing program. The major areas of impact include that costs associated with: the air emissions plans required for all facilities greater than 1,000 animal units (part 7020.0505, subpart 4, item B (1)), the restriction to keep livestock on pastures out of lakes (part 7020.2015, subpart 3), the restrictions associated with design standards which do not allow piping to penetrate manure storage area liners (part 7020.2100, subpart 3, item C), the requirement to have construction inspections for liquid manure storage areas (part 7020.2100, subpart 6), and the requirement to hire a design engineer to evaluate the soils investigation and prepare a report (part 7020.2110, subpart 2, item B). All facilities owners in this class will not be impacted by these costs. The proposed rules do offer cost benefits for some facility owners and operators in the form of a streamlined permitting process for the majority permits, and a stepped approach to solving open lot runoff problems at facilities with less than 300 animal units.

Delegated Counties

More than 50 counties have accepted delegation to process permits under Chapter 7020. In general, there will be no additional cost over existing requirements. The proposed rule is designed to be flexible to meet the needs; resources; and the varying demands associated with the varied number of feedlots, manure storage areas and pastures that are unique to each county. Some counties will elect to increase staff and establish aggressive goals that will require additional resources. However, this is not a requirement of the proposed rules. The MPCA is proposing to include a new program component - registration, increase inspections, require the preparation of an annual report, and increase the scope of potential permittees from facilities with less than 300 animal units to facilities with less than 1,000 animal units that are not required to have an NPDES or SDS permit. The work associated with these responsibilities will be offset by the reduction in work that will result from eliminating the requirement to issue certificates of compliance and removing the requirement to have a permit to construct, expand or modify an animal feedlot or manure storage area that will result in less than 300 animal units when the construction is done in accordance with the proposed technical standards.

Persons Concerned About Environmental Quality

This class includes people that live near livestock facilities, citizens concerned about environmental impacts associated with livestock agriculture and citizens concerned with water and air quality in Minnesota. Persons in this class will not experience a direct cost impact because they are not conducting activities that are regulated by Chapter 7020. However, this class will realize a cost benefit over time in the form of a cleaner environment, as existing pollution issues, such as runoff from small open lots, are resolved.

State Government

The proposed rules will not impact state government agencies other than the Minnesota Pollution Control Agency (MPCA), which is the only state agency that regulates animal feedlots, manure storage areas, and pastures for pollution issues. The MPCA currently has a regulatory program for this purpose. The MPCA is proposing to add the registration to this existing program. Registration will require administrative work that is currently not being performed by the MPCA. The MPCA is also re-designing the existing regulatory program. See the Program Plan (Exhibit I-4) for a discussion of this re-design effort. The MPCA is not requesting additional resources because the work required to complete registration will be offset by the reduction in work realized from streamlining the permitting process and reducing the time required to issue permits; eliminating the certificate of compliance, which typically doubled staff work load in conjunction with permitting; and removing the requirement to have a permit to construct, expand or modify an animal feedlot or manure storage area that will result in less than 300 animal units when the construction is done in accordance with the proposed technical standards.

Table 7. Discussion of Cost Differences Between Current Requirements and Proposed Requirements

Rule Part	Heading/Title	Cost Differences Between Proposed and Existing Requirements
7001.0020, Item F.	Agency Permit Procedures, Scope	<u>State government impacts</u> This rule part only refers to administrative procedures that will be performed by MPCA staff and delegated counties. No additional costs are expected from changes

Rule Part	Heading/Title	Cost Differences Between Proposed and Existing Requirements
		to these procedures because procedures for interim permits and NPDES, and SDS permits remain the same. Proposed amendments relate to a new permit tool, construction short-form permit, which will have the same procedural costs as the interim permits. Delegated Counties Introduction of construction short form permit will result in little or no additional procedural costs because the process established under this part is the same as the process for the existing interim permits currently being issued by the delegated counties.
7002 7002.0210 to 7002.0280	Permit Fees Permit Fee Structure for NPDES, SDS, Construction Short Form and Interim Permits	State Government The MPCA will realize no additional fee revenue from the proposed amendments. The MPCA has included in its fee allocation, the expected fee revenue from issuing an NPDES permit to all facilities with 1000 or more animal units. Therefore, fees proposed to be collected for the SDS permit will replace the fees that would have been collected as NPDES permit fees. Livestock Owners and Operators The proposed changes do not change the fee amounts that are already established under Chapter 7002. The MPCA is currently charging fees for NPDES permits that regulate animal feedlots, manure storage areas or pastures. SDS permit fees are the same as NPDES permit fees and will only be issued to facilities that would normally receive an NPDES permit, therefore no additional costs will be incurred. The MPCA is proposing no fees for Interim Permits, Construction Short-form permits, and SDS permits issued to facilities with less than 1000 animal units.
7020 7020.0200 7020.0205 7020.0250 7020.0300	General Scope Incorporation By Reference Submittals And Records Definitions	These parts are for clarification purposes and the actual requirements would result in incurred costs are discussed in other parts of the rules.
7020.0350	Registration	State Government

Rule Part	Heading/Title	Cost Differences Between Proposed and Existing Requirements
	Requirements For Animal Feedlots, Manure Storage Areas and Pastures	The registration program will be a new responsibility for the MPCA. However, The MPCA is not requesting additional resources to administer this program. Instead the agency is redesigning its permitting procedures to free up existing resources to administer this program. See Exhibit I-4. The information received through the registration process will allow the MPCA to more effectively determine pollution concerns and then use its resources more effectively by targeting its efforts. <u>Livestock Owners and Operators</u> The cost is negligible; the only cost associated with this requirement is the cost to complete the form, which only requires information that should be readily available to the owners/operators. This should require only a minimal amount of time. Many operators will meet this requirement without spending any additional time because the will have met the requirement as the result of a level 2 or 3 county inventory or a permit application submitted after the effective date of these proposed rules. <u>Delegated Counties</u> Impacts for the registration program are included in the discussion under part 7020.1600. <u>Persons Concerned with Environmental Quality</u> Because of this program, the MPCA will be receiving more information about the potential pollution sources. This information will allow the MPCA to more effectively make decisions that will result in environmental gains for the state.
7020.0400	Permit Program	This part is for clarification purposes only.
7020.0405	Permit Requirements	<u>State Government</u> The proposed rules will result in a streamlined permit delivery system for the agency. The combination of the short-form permit, interim permit, and technical standards that are proposed in this rule will result in less administrative time for completing a permit. <u>Livestock Owner and Operators</u>

Rule Part	Heading/Title	Cost Differences Between Proposed and Existing Requirements
		Proposed rules will regulate the same animal unit category range (50 animal units and 10 animal units in shoreland) as in the current rules. The MPCA's proposal to use technical standards established in the rules to develop interim and construction short form permits will result in a streamlined permitting process. This streamlined process is expected to benefit the facility owners in a positive way by minimizing construction cost overruns that result from permit backlogs and issuance delays. The proposed rules do not require owners with less than 300 animal units to acquire a permit for the construction of a new facility or the expansion of an existing facility if construction is in accordance with the technical standards established in the proposed rules. This will save these owners the time and expense of completing a permit application, working with the MPCA or a delegated county to acquire a permit, and retrofitting construction plans to meet the permit process requirements. <u>Delegated Counties</u> See discussion under part 7020.1600.
7020.0505	Permit Applications	<u>State Government</u> The proposed rules will require no additional administrative costs to process a permit application because the items proposed to be required on the permit application are essentially the same items currently required under part 7020.0500. <u>Livestock Owner and Operators</u> The existing requirements and the proposed requirements are the same 7020.0505 subpart 4 item B requires the preparation of an air emission plan, pollution prevention plan, and an emergency response plan. This rule part results in additional costs for livestock owners and operators. These costs have been estimated and included in the additional costs part of the Implan modeling section of the economic impact analysis proposed as a permit application requirement for facilities with 1,000 or more

Rule Part	Heading/Title	Cost Differences Between Proposed and Existing Requirements
		animal units. Facilities under 1,000 animal units may be requested to submit the air emission plan if the MPCA determines the facility poses a high priority environmental issue. Submitting the plan, when required, with the permit application is a new requirement. Air emission plans are currently required when the site specific evaluation conducted as part of the permit development process or an environmental assessment determines there is a need for this plan. An engineer or other professional with expertise in this area is not required to complete these plans. Direct costs will be incurred if a facility owner elects this service. Indirect costs will be incurred by owners that prepare their own plans. The MPCA will be providing guidance on how to prepare an effective plan to help owners prepare their own plans and minimize the time required to prepare the plans. The MPCA estimates that 6 to 15 hours are required to prepare this plan. Subpart 4, item D, requires certification of notification. This notification is required by statute and affected owners are currently meeting this notification. Therefore there is no additional cost. <u>Delegated Counties</u> Existing interim permit applications require the same information for most applications. Therefore, there will be no additional costs for the delegated counties associated with processing the proposed applications.
7020.0535	Construction Short-Form and Interim Permits	<u>State Government</u> Establishing the permit requirements in the rules helps the MPCA establish a streamlined permit process. Staff time is not spent re-designing the permits each time that one needs to be issued and minimal negotiation is required to develop the permit. This approach reduces staff resources needed to issue interim and construction short form permits. <u>Livestock Owner and Operators</u> The conditions and requirements proposed to be required under the construction short form permits and the interim permits are essentially the same requirements that are

Rule Part	Heading/Title	Cost Differences Between Proposed and Existing Requirements
		currently required under interim A and B permits. The technical standards under parts 7020.2000 to 7020.2225 that are being proposed to be permit requirements have been established and utilized as regulatory policy and currently are being incorporated into interim A and B permits. Therefore, the requirements under the proposed construction short form permits and the interim permits will impose no additional costs to facility owners compared to current permit requirements. Establishing the permit requirements in the rules rather than as individual permits streamlines the permitting process, which is expected to benefit the facility owners in a positive way by minimizing construction cost overruns that result from permit backlogs and issuance delays. Delegated Counties Delegated counties will realize the same benefits as state government.

Rule Part	Heading/Title	Cost Differences Between Proposed and Existing Requirements
7020.1600	Authorities and Requirements for Delegated Counties	State Government The MPCA is proposing a new component to the county delegation – the delegation agreement. This new tool will require an MPCA staff person to annual review the delegation agreements and work with each county to update the agreements when necessary. This work will require little time because it will be combined with the existing work being done for the county block grants. Delegated Counties The MPCA is proposing to include the administration of registration, increased inspections, the preparation of an annual report, increasing the scope of potential permits from facilities with less than 300 animal units to facilities with less than 1000 animal units that are not required to have an NPDES or SDS permit. The work associated with these responsibilities will be offset by the reduction in work that will result from eliminating the requirement to issue certificates of compliance and removing the requirement to have permit to construct, expand or modify an animal feedlot or manure storage area, that will result in less than 300 animal units when the construction is done in accordance with the proposed technical standards. We don't expect counties to hire new staff or to incur new expenses for additional equipment needed to run the program, however the changes in the specific activities that are done by CFO's for example, time spent under the current program processing permit application and issuing permits would be shifted to implementing the registration program and greater field presence. This shift is realized in part through the construction short form permit process. The construction short from permit and technical standards work together to reduce the amount of time draft and issue permits. Staff will also have additional time that is currently being spent to issue permits to owners with than less than 300 animal units constructing a new facility or expanding and existing facility. In addition, the delegation agreement proposed in the rule amendments provides the flexibility to design the

Rule Part	Heading/Title	Cost Differences Between Proposed and Existing Requirements
		program to meet a county's individual resources, goals and needs. This will not necessarily require an increase in staff. A county may choose to increase their staff size.
7020.2000 to 7020.2225	Standards for Discharge, Design, Construction, Operation and Closure	Livestock Owners and Operators Expected to result in cost savings to producers due to reduced delays in commencing construction for new facilities and expansions of facilities that are under 300 animal units in capacity. Under 300 animal unit facilities account for an estimated 80% of the facilities that exist in Minnesota. Historically, the agency has accumulated a backlog of permit applications resulting in unanticipated delays for producers. Unanticipated delays often result in unanticipated costs for producers such as increased costs of construction. An example of this would be if as a result of a permit delay, construction was delayed until winter resulting in more costly construction. In addition delays result in lost production time resulting in lost revenues for producers. The registration program should result in significantly reduced delays resulting in significant cost savings to the industry. There is no data available on exactly how much delays are costing the industry therefore there is no dollar value assigned to these costs savings.
7020.2000	Overview	This section contains requirements for manure not used as domestic fertilizer, manure packs and mounding and notifications to the local public and agency or delegated county. These requirements exist under the current feedlot program, therefore, there are no additional costs anticipated by this part.
7020.2002	Hydrogen Sulfide Ambient Air Quality Standard Applicability	Livestock Owners and Operators This exemption is anticipated to effect a very small number of facilities. Cost savings may be realized at facilities that struggle to lower their emissions during agitation and pumpout. There is no data from which to make a calculation on the amount of cost savings that could result from this rule part. It is expected that the amount of cost savings will be insignificant to the livestock sectors as a whole. Persons concerned with environmental quality

Rule Part	Heading/Title	Cost Differences Between Proposed and Existing Requirements
		This provision may result in costs (e.g., air conditioning systems, clothes dryers instead of hanging on clothes-lines, etc.) for neighbors of facilities for which BMPs are not working adequately to limit emissions.
7020.2003	Water Quality Discharge Standards	Livestock Owners and Operators This rule part is expected to result in cost savings to livestock facilities that have runoff from open lots and are under 300 animal units. Example: John Doe has a 200 head dairy operation with outside open lots that currently have a runoff problem. John Doe hasn't expanded or built any new operations for a number of years and therefore has not had his facility reviewed by MPCA to see if it is in compliance with 7020 feedlot rules and 7050.0215 discharge standards. If John Doe decided to get a MPCA permit or was discovered by MPCA staff under the current program, he would receive an interim B permit. This permit would require him to develop a plan to fix his existing problem within 10 months. After plans were submitted he would be issued an interim A permit which would give him another 10 months to install the corrective system. This would give him a grand total of 20 months to install corrective measures. If the proposed rules were adopted, John Doe would have more time to correct his system. He would have until October 1, 2003 to install inexpensive corrective measures to reduce runoff by approximately 50%, and he would have another 6 years to install final corrective measures to reduce pollution completely. Therefore the new rules would result in a costs savings for John Doe because he has a much longer time in which to come into compliance.
7020.2005	Location Restrictions and Expansion Limitations	Livestock Owners and Operators Current MPCA requirements do not allow construction or expansion of facilities that would impact water quality. Location or expansion of facilities in the areas restricted by the proposed language would result in impact to water quality and therefore would not be allowed under the current program. Most of the farms located within shoreland were built prior to 1974 when the shoreland ordinance went into effect. The shoreland ordinance was

Rule Part	Heading/Title	Cost Differences Between Proposed and Existing Requirements
		established to restrict construction in these environmentally sensitive areas. As a result most counties in the state have prohibited construction within these shoreland areas The rule language won't prohibit them from continuing to use these barns if they are not causing an environmental impact. It will just impact future expansion opportunities within the setback areas. <u>Persons Concerned about Environmental Quality</u> This proposed rule part will result in increased protection of water quality, benefiting persons concerned about environmental quality.
7020.2010	Transportation of Manure	<u>Livestock Owners and Operators</u> No new additional costs. This rule part is not requiring anything different than would be required under the current Minnesota Department of Transportation Rules or the Current MPCA requirements. See SONAR for this rule part for more explanation.
7020.2015	Livestock Access to Waters Restriction	<u>Livestock Owners and Operators</u> Subpart 1 and Subpart 2 are no different than current requirements. Pasture facilities covered by subpart 3 are not directly addressed by the existing requirements. This rule part results in additional costs for livestock owners and operators. These costs have been estimated and included in the additional costs part of the Implan modeling section of the economic impact analysis. <u>Persons Concerned about Environmental Quality</u> This proposed rule part will result in increased protection of water quality, benefiting persons concerned about environmental quality.
7020.2025	Animal Feedlot or Manure Storage Area Closure	<u>Livestock Owners and Operators</u> No new additional Costs. This rule part is not imposing any additional costs beyond those that are imposed under current requirements. The requirements of this proposed rule part are identical to current MPCA requirements.
7020.2100	Liquid Manure Storage Areas	<u>Livestock Owners and Operators</u>

Rule Part	Heading/Title	Cost Differences Between Proposed and Existing Requirements
		The existing requirements and the proposed rule are identical in all aspects except; 7020.2100 subp 3 item C which doesn't allow any piping to penetrate the liners, 7020.2100 subp 4 item A which requires installation of drain tile at all systems, and 7020.2100 subp 6 which requires inspection of construction of liquid manure storage areas. This rule parts result in additional costs for livestock owners and operators. These costs have been estimated and included in the additional costs part of the Implan modeling section of the economic impact analysis. Persons Concerned about Environmental Quality This proposed rule part will result in increased protection of water quality, benefiting persons concerned about environmental quality.
7020.2110	Non-Certified or Unpermitted Liquid Manure Storage Areas	Livestock Owners and Operators The existing requirements and the proposed rules are identical in all aspects except subpart 2, item b that requires the owner to have a design engineer conduct a soils investigation and submit a soils investigation report. This results in additional costs for livestock owners and operators. These costs have been estimated and included in the additional costs part of the Implan modeling section of the economic impact analysis. Persons Concerned about Environmental Quality This proposed rule part will result in increased protection of water quality, benefiting persons concerned about environmental quality.
7020.2120	Poultry Barn Floors	Livestock Owners and Operators Current requirements for poultry barn floors to be constructed to standards equivalent to the standards proposed in the new rule language. Therefore there will be no additional costs associated with the proposed rule language. The proposed rule language provides a larger number of options than what was been allowed under current requirements.
7020.2125	Manure Stockpiling	Livestock Owners and Operators A lot of the operations as they are operating now will fit

Rule Part	Heading/Title	Cost Differences Between Proposed and Existing Requirements
	Sites	under the proposed permit stockpiling requirements. The permit-stockpiling requirement may require them to construct a cement pad or establish a system that results in cost savings. However, from discussions at FMMAC meetings and owners and operators the agency has concluded that most owners in this situation will change their stockpile practices to be in compliance with the short-term stockpile requirements. Therefore owners avoid the potential cost increases associated with the proposed permanent stockpiling requirements, short-term stockpiling or other measures that may result in cost impacts. Therefore any costs associated with this rule part are insignificant due to the proposed requirements. The requirements do not require the installation of any type of barrier but rather place requirements on the management of stockpiling sites. <u>Persons Concerned about Environmental Quality</u> This proposed rule part will result in increased protection of water quality, benefiting persons concerned about environmental quality.
7020.2150	Manure Compost Sites	<u>Livestock Owners and Operators</u> Currently manure composting is regulated by 7035.2836. This proposed language does not impose any additional costs. More discussion can be found in this SONAR for this rule part. <u>Persons Concerned about Environmental Quality</u> This proposed rule part will result in increased protection of water quality, benefiting persons concerned about environmental quality.
7020.2225	Land Application of Manure	<u>Livestock Owners and Operators</u> The current rule requires a manure management plan to be included as part of the application process. The proposed rule requires a manure management plan and adds a requirement for manure testing and soil testing. This additional testing does have a cost associated with it, however, as discussed in this SONAR for this rule part the costs may be off set by the costs savings associated with more accurate commercial fertilizer applications as a result of the knowledge acquired by the testing. A

Rule Part	Heading/Title	Cost Differences Between Proposed and Existing Requirements
		commonly used manure management planning tool is the computer program entitled Manure Application Planner. This program will show the commercial fertilizer cost savings associated with accurately accounting for the nutrient content of your manure and the nutrient needs of your cropland. An example of the information this program provides has been included (Exhibit E-6). Other papers discussing the value of manure have been included (Exhibits E-7 to E-10). The MPCA feels that the costs associated with manure management planning under the proposed rules are offset by the costs realized by more accurate commercial fertilizer use. Therefore, the various agriculture sectors should not incur any additional costs and may in fact realize costs savings. <u>Persons Concerned about Environmental Quality</u> This proposed rule part will result in increased protection of water quality, benefiting persons concerned about environmental quality

B. Modeling of Economic Impact

Economic impact analyses were used to estimate the effects of proposed rules for feedlot operators. Production cost increases in Minnesota's agricultural production sectors are assumed to be the primary economic effects of proposed rule changes. Analysis indicates that total annual production cost increases could begin in 2000 at $4.2 million per year, and last until 2002. After that, annual cost increases are expected to drop to $1.2 million.

Some other findings include:

- The proposed rules will not likely have a significant effect on Minnesota's general economy;
- There may be slight declines (in the 0.1 per cent to 0.2 per cent range) in output and employment in the agricultural sectors that are directly affected by the proposed rules;
- In economic sectors that are not directly affected by the proposed rules it is likely that there will be no noticeable impact; and
- Directly affected sectors: dairy, cattle, hog and poultry production; will likely incur nearly all of the economic burden imposed by the proposed rules.

Economic impact analysis estimated the effects of proposed regulations that will apply to feedlot operators. Environmental regulations' direct economic effects generally take the form of increasing production costs. Conventional regulations require manufacturers to install and operate pollution control equipment. Fees impose direct costs on waste dischargers. Trading systems generally operate from a regulatory basis that imposes costs, which are redistributed as trading partners exchange pollution allowances. And administrative costs accompany nearly all environmental policy changes.

Cost changes are generally the first effects considered in an economic impact analysis of environmental regulations. Costs are the most obvious economic effects, especially to the communities and firms that confront new regulations. However, market activity spreads direct cost impacts beyond the point of initial contact. (Recent analyses indicate that dynamic responses to market change tend to dampen direct impacts.) When firms that produce goods or provide services incur new costs, they must find financial means to cover the new costs. Five options are generally available:

- Increase selling prices;
- Cut expenses in some other area of business activity;
- Accept reduced profits;
- Make productivity-enhancing changes that will lower production costs; or
- A combination of the first four options.

All of the financial options imply further impacts on customers, competitors, suppliers, employees or investors. Moreover, policy changes that influence government spending and taxes affect taxpayers and those who benefit from government programs.

Cost increases are not the only economic effects of environmental policy changes. Often, costs imposed on one firm mean increased sales for other firms. In the case of a regulation that requires installation of pollution control equipment, manufacturers, designers, installers, monitoring and analytical firms may all sell goods or services to regulated firms. A thorough environmental economic impact analysis takes into account all economic effects (direct and indirect, costs and increased sales) and combines them in an evaluation of the net effects expected from a change in environmental policy. However, in order to make a conservative estimate, this analysis excludes offsets due to increased sales in some sectors. The next section has a brief description of the model used to simulate environmental policy changes.

Simulation of Economic Impacts

Simulation of the economic effects related to proposed rule changes is a three-step process. First, an economic model calculates a “baseline” that describes current economic conditions. Next, variables within the model are changed to simulate the effects of the proposed rules and the model’s estimates are recalculated under the changed conditions. This step yields a “simulation forecast.” Finally, differences between the baseline and the simulation forecast estimate the economic impacts of the simulated changes. The graph illustrated in Exhibit E-5 shows a picture of how the analysis is made.

The graph shows differences between the simulation forecast and the baseline. The differences estimate the impact of the proposed change on employment. When the simulated effect is above the baseline value, higher employment is expected. Lower employment is expected when the simulation drops below the baseline. Comparing simulation and baseline values yields an estimate of *net* impacts.

Estimates of economic impact first cover direct effects on specific economic sectors, such as agricultural production sectors. Impact estimates broaden out to include indirect effects (caused by changes in producers' supply and demand) and induced effects (caused by changes in consumer demand) on all of the state's economic sectors.

The IMPLAN Model

This model simulates economic impacts by solving a set of equations that describe the interrelated activities of the state's economy. National data compiled by federal agencies comprise IMPLAN's statistical foundation. Input/output (I/O) tables, developed by the U.S. Commerce Department's Bureau of Economic Analysis, provide a foundation structure for the model's description of Minnesota's economy. The I/O tables describe how economic sectors relate to each other.

An economy, like a natural system, consists of identifiable groups that interact in complex and dynamic ways. Business firms, nonprofit organizations and governments produce goods and services (supply) to meet the consumption needs (demand) of people and their organizations. A firm's output can satisfy either final demand (e.g., groceries) or intermediate demand (e.g., paper stock), in which case the product is used to make new goods or provide new services.

Each economic sector in the I/O tables relates to every other sector in a way that is based on the resources (in the form of goods or services) it demands from other sectors. Likewise, each sector supplies some part of its final output to other sectors and/or to final demand. The strength of these relationships varies, depending on the specific conditions of each sector. Consider an example:

Rows in the I/O table show the units of output from one sector that provide intermediate inputs (e.g., raw materials used to manufacture goods) for itself and other sectors along with output of finished goods and services. The service sector in this table provides 10 units to agriculture, 70 units to manufacturing, 55 units to itself and 105 units to final demand. This adds up to 240 units, which is called gross output. Columns show each sector's demand for goods and services, and the "value added" produced in each sector. The service sector buys 20 units of agricultural output, 90 units of manufacturing output and 55 units of its own output. Value added is the measure of the value that economic activity within a sector has added to the inputs it buys. Notice that the value added is equal to gross output less the sum of the inputs demanded by the sector. In the example, value added for the service sector is 240 - (20+90+55) = 75.

Table 8. Hypothetical Economic Input-Output Table.

	Agriculture	Manufacturing	Services	Final Demand	Gross Output
Agriculture	60	60	20	60	200
Manufacturing	40	25	90	80	235
Services	10	70	55	105	240
Value Added	90	80	5	245	
Gross Output	200	235	240		

The example is kept simple for instructive purposes. IMPLAN's basic I/O tables have over 500 economic sectors. The value of the I/O tables for this analysis is that any change made in one sector has effects in all other sectors. This feature means that the IMPLAN model provides a comprehensive way to take indirect effects into account. The model also takes into account the relative strengths of intersectoral impacts, which depend on the extent to which some sectors rely on other sectors for productive inputs or economic demand. Thus, changes induced in one specific sector will have only slight effects on another sector that either demands little of the changed sector's output or supplies few of the changed sector's inputs. Conversely, a heavily dependent sector will be strongly affected by induced changes. A Social Accounting Matrix extends IMPLAN's I/O foundation to include the "institutions" (such as households and government) that demand final goods and services from producing firms.

Relationships in the IMPLAN model are linear. That is, changes cause impacts that are proportionate to the relative size of the change. For example, if a ten per cent change in output for one sector causes a two per cent change in overall output, then decreasing the original change to five per cent will decrease the overall impact to one per cent. The linearity assumption is made for simplicity. Economic impacts in the real world do not occur as simple linear extensions of past trends. Many factors (e.g., price changes, labor mobility, interest rates, consumers' choice, producers' choices, taxes, etc.) come into play when economic decision makers adapt to change. Capacity limits require available models to accept trade-offs. If a model is to include detailed and adaptable independent variables, its scope is usually rather broad. That is, a model with detailed economic arguments usually covers only a relatively few economic sectors. On the other hand, if a model covers a more specific range of economic sectors and regions, it usually is not as detailed in its economic arguments. Models that cover all bases are large and too expensive. In the interest of economy, time and adequate coverage of agricultural production sectors, the MPCA used the IMPLAN model for simulation analysis.

Results from the IMPLAN model are defined in terms of a set of standard economic variables. Usually, readers are interested in evaluations that cover employment and output. Other measures of economic impact are also available (e.g., value added), and will be provided only if they are called for later on.

Before looking at the results, a warning about models seems useful. Models are analogous to maps. Like maps, they have many possible purposes and uses and no one map or model is right for the entire range of uses. It is inappropriate to think of models or maps as anything but crude (but in many cases absolutely essential) abstract representations of complex territory, whose usefulness can best be judged by their ability to help solve the navigational problems faced. Models are essential for policy evaluation, but are often also misused since there is '... the tendency to use such models as a means of legitimizing rather than informing policy decisions. By cloaking a policy decision in the ostensibly neutral aura of scientific forecasting, policy-makers can deflect attention from the normative nature of that decision ...'[1]

Impacts Estimated by the Model

Current Conditions

Current IMPLAN estimates derive from 1996 statistics (the latest data available in IMPLAN) compiled by federal agencies such as the Commerce Department and the Bureau of Labor Statistics. Our analysis focuses on three features of the state's economy:

- The economic variables that usually interest everyone, economic output and employment;
- Estimated impacts on the overall state economy; and
- Estimated impacts in the agricultural production sectors that will be affected directly by the proposed rules.

Estimates of economic output and employment for the entire state and in the affected sectors are presented in Table 9.

Other economic variables and regions can be analyzed, if it turns out that reviewers want to know more about the proposed rules' economic impacts with respect to other economic variables or in regions smaller than the entire state.

[1] Costanza, Robert, "Ecological Economics: Reintegrating the Study of Humans and Nature," Ecological Applications, 6(4), 1996, pp. 978 – 990. Also cited within this paragraph are: a) Levins, R., 1966, "The Strategy of Model Building in Population Biology," American Scientist, 54:421-431, b) Robinson, J.B. 1991, "Modeling the Interactions between Human and Natural Systems," International Social Science Journal, 130:629-647, and c) Robinson, J.B. 1992, "Of Maps and Territories: the Use and Abuse of Socio-economic Modeling in Support of Decision-making," Technological Forecasting and Social Change, 42:147-164.

Table 9: Baseline Economic and Employment Values for 1996.

Summary Statistics	State Total	Dairy	Hogs	Poultry	Cattle
Economic Output (Millions of Dollars)	$263,003	$1,378	$1,171	$782	$503
Employment (Number of Jobs)	3,066,081	6,403	13,797	2,660	2,178

Estimated Costs

The Implan model has been run using the cost estimates for the proposed requirements that are expected to result in a cost increase for the Livestock Owners and Operators. As noted in the discussion of the cost differences between the existing requirements and proposed requirements, the MPCA anticipates cost savings associated with certain rule parts. Values for these cost savings have not been quantified and were excluded from the model. By excluding the cost savings, the model would be showing a conservative estimate for the amount of impact on each of the livestock sectors. The MPCA anticipates that the impact to each of the major livestock sectors would be less if cost savings were included in the modeling.

Table 10. Estimated Costs of Proposed Rule Parts on Major Livestock Sectors.

Proposed Rule Part	Estimated Costs for Dairy Sector (Dollars)	Estimated Costs for Beef Sector (Dollars)	Estimated Costs for Swine Sector (Dollars)	Estimated Costs for Poultry Sector (Dollars)
7020.0505, subp. 4, item B, in year 2000	150,000	350,000	920,000	80,000
7020.0505, subp. 4, item B in year 2001	150,000	350,000	920,000	80,000
7020.0505, subp. 4, item B in year 2002	150,000	350,000	920,000	80,000
7020.0505, subp. 4, item B in year 2003 and beyond	30,000	70,000	180,000	20,000
7070.2015, Subp. 3 in year 2000	630,000	370,000	40,000	------
7070.2015, Subp. 3 in year 2001	630,000	370,000	40,000	------

Proposed Rule Part	Estimated Costs for Dairy Sector (Dollars)	Estimated Costs for Beef Sector (Dollars)	Estimated Costs for Swine Sector (Dollars)	Estimated Costs for Poultry Sector (Dollars)
7070.2015, Subp. 3 in year 2002	630,000	370,000	40,000	------
7020.2100, Subp. 3 in year 2000 and beyond	50,000	10,000	90,000	------
7020.2100, Subp. 4 in year 2000 and beyond	10,000	--------	30,000	------
7020.2100, Subp. 6 in year 2000 and beyond	250,000	50,000	450,000	------
7020.2110, Subp. 2, item B in year 2000	700000	20000	10000	------
7020.2110, Subp. 2, item B in year 2001	700,000	20,000	10000	------
7020.2110, Subp. 2, item B in year 2002	700,000	20,000	10,000	------

Explanation of Cost Estimates

Minn. R. pt. 7020.0505, subp. 4, item B, requires an air Emissions plan, pollution prevention plan and emergency response plan to be included with the permit application for facilities greater than 1000 animal units. The MPCA is assuming it will take three years to get the existing 800 facilities over 1000 animal units issued with NPDES permits. Therefore the costs associated with preparing plans for these 800 facilities will be spread over the year 2000, 2001, and 2003. In addition, MPCA expects to issue about 200 or less new or revised permits for facilities greater than 1000 animal units annually. This costs has been added to the cost of getting the existing 800 facilities into compliance in the years 2000,2001,2002. An estimate of $1,500 dollars was used for the preparation of these plans. The annual cost of this rule part for the years 2003 and beyond is shown in the table and has been used in the IMPLAN model. The estimate of 200 facilities was projected by looking at the number of permits issued in recent years for facilities greater than 1000 animal units (Exhibit E-4). The dollar amounts for these additional costs were broken down by sector as shown in Table 10. Table 10 does not address costs for non-major animal type sectors (e.g., horses, sheep and non-traditional animal types) for which the agency assumes that there will be little or no cost.

Minn. R. pt. 7020.2015 Livestock Access to Lakes Restriction Subp. 3, Pastures. This part requires livestock operators to fence livestock out of lakes or to restrict access. The costs for fencing are dependent on the type of fencing and are expected to range from approximately $.50-$1.50 (Exhibit E-12). The costs for controlling access will be widely variable depending on which option is chosen. The options range from the low cost option of preparing a prescribed grazing plan to the expensive option of controlling access with a concrete ramp and fencing. The range is estimated to be from 50 to 5000 dollars or more depending on site conditions. The agency is using the midpoint of this range as an average cost for each of the sectors. The number of facilities impacted by this requirement is unknown. However, the MPCA database (Exhibit E-11) indicated that there are approximately 2010 facilities within 100 meters of a lake under 300 animal units in the MPCA's database. MPCA's database is estimated to contain about 40% of all facilities. Facilities under 300 animal units are expected to constitute nearly all of the facilities that are within 1000 meters of a lake. Therefore the MPCA roughly estimates that there are approximately 5000 facilities in total are located within 1000 meters of a lake. The MPCA does not know how many of these have pastures that are adjacent to lakes. To ensure that we do not neglect any additional costs associated with this rule Subpart, the MPCA is estimating that approximately 25% of these facilities will have pastures that are adjacent to lakes. This will give what the agency feels is a conservative estimate of the number of facilities that will be impacted by this rule part. The costs for getting the existing facilities into compliance has been spread out over the years 200o,2001, and 2002. The dollar amounts for these additional costs were broken down by sector as shown in Table 10.

Minn. R. pt. 7020.2100 liquid manure storage areas, subpart 3, design standards. This part results in an additional cost to avoid running lines through concrete pits and manure basins. MPCA estimates this will cost an average of $500.00 per facility to keep all pipelines outside of the storage structures. Using data for recent years (Exhibit E-4) and choosing a number higher than expected, the MPCA estimates that there will be approximately 300 or less for manure storage structures built annually. The dollar amounts for this additional cost were broken down by sector as shown in Table 10.

Minn. R. pt. 7020.2100 Liquid Manure Storage Areas subpart 4, Design Plans and Specifications. This subpart will require a drain tile to be installed at all facilities. Currently, permits issued by feedlot operators require drain tile to be installed under almost all conditions. Therefore this is expected to impact only 20 projects per year at 2000 dollars per project. The dollar amounts for this additional cost are broken down by sector and shown in Table 10.

Minn. R. pt. 7020.2100 Liquid Manure Storage Areas, Subpart 6 Inspection. The additional costs associated with requiring an inspection are estimated at $2500 per facility. This is expected to impact 300 or fewer facilities per year. The dollar amounts for this additional cost were broken down by sector as shown in Table 10.

Minn. R. pt. 7020.2110 Unpermitted or Non-Certified Liquid Manure Storage Areas, Subpart 2 item B requires a design engineer certified soils investigation. The hiring of the design engineer is an additional cost over what is currently required. This cost is estimated to be approximately $1000 per facility. There are an estimated 6000-8000 facilities with unpermitted basins. The MPCA is estimating that approximately 3000 of these facilities will elect the option of hiring a design engineer to certify soils investigations indicating whether or not their basin is adequate. This rule part has a deadline of October 1, 2003. Therefore these costs have been spread out over the years 2000,2001,2003. The costs were broken down by sector as shown in Table 10.

The annual cost estimates from 2000 to 2002 add up to a little over $4 million. Estimated costs decline after 2002 and are expected to total slightly more than $1 million until all affected facilities are upgraded to meet the proposed rule requirements. These estimated annual costs are summarized in Table 11.

Table 11. Summary of Estimated Annual Costs.

Economic Sector	Annual Costs 2000 to 2002	Annual Costs 2003 and Beyond
Dairy	$1,790,000	$340,000
Beef	$800,000	$130,000
Swine	$1,540,000	$750,000
Poultry	$80,000	$20,000
Total	$4,210,000	$1,240,000

Simulation Assumptions, Conservative Bias

Recall the discussion in the Introduction section about the financial options business firms' have when they confront the need to comply with costly regulations. Five options were mentioned:

- Increase selling prices;
- Cut expenses in some other area of business activity;
- Accept reduced profits;
- Make productivity-enhancing changes that will lower production costs; or
- Combination of the first four options.

Individual farm operators cannot influence prices, but they can manage price risk by using futures markets to guarantee a favorable price. We expect that farm operators will comply with the proposed rules by choosing the mix of financial options that best suit their financial conditions. However, available information does not support even qualified guesses about the specific choices that farm operators will make. So the simulation of economic impacts assumes that all farm operators will choose the second option – cutting other expenses in order to pay for compliance. The affect of this assumption on the IMPLAN baseline is to reduce directly the economic output of the agricultural sectors that will be affected directly by the proposed rules. Simulating the rules' impacts in this way has two advantages:

- It is simple, perhaps even simplistic. It can be easily described and easily introduced into the IMPLAN model.
- It is conservative. If there is a chance that the proposed rules may have a significant economic impact, we want to be sure that chance is recognized in the simulation analysis. Assumptions should not hide possible economic impacts. Using conservative assumptions about the proposed rules' financial effects helps to highlight potential negative impacts.

Simulation Results

When economic output in the affected sectors is reduced by the estimated annual costs of the proposed rules, small reductions in total output and employment result. Model simulations were made for two periods. Requirements that apply from 2000 to 2002 are expected to impose higher costs than the requirements that will take effect after 2002. Simulated impacts are greater during the 2000 – 2002 period because assumed cost increases are significantly greater.

Direct effects are the cost increases (simulated as output reductions) that occur when feedlot operators comply with the proposed rules. Indirect effects occur when changes in one economic sector cause changes in the sectors that either sell inputs to or buy products from the affected firms. For example, a reduction in output from feedlots will likely cause a reduction in feed grain purchases. Induced effects occur when changes in household income change final demand patterns. If farm proprietors make less profit, farm households will cut back on their purchases of goods and services.

Although the simulated reductions (during the 2000 to 2002 time period) in directly affected sectors appear small, they may not be considered insignificant. There is no standard that tells us when an economic impact should be considered significant. Consider, for discussion, a rule of thumb that relates to news coverage of economic issues. News media tend to pay attention to economic changes when they reach or exceed one tenth of a percentage point. Changes in employment, gross domestic product, prices and trade balances that exceed 0.1 per cent tend to get noticed. Smaller changes are not reported as often by news media. Changes of one per cent or greater are nearly always reported and can cause significant concern if they move in the wrong direction. So, the rule of thumb has two parts: 1) changes greater than 0.1 per cent should be noticed and discussed and 2) changes greater than one per cent should be considered significant.

Simulation results show that the proposed rules are unlikely to have a noticeable effect on the overall state economy. However, the results do show that there may be noticeable short-term impacts in the dairy, hog and cattle production sectors. These noticeable impacts do not exceed 0.2 per cent for any of the affected sectors. Estimated impacts in the affected sectors drop below 0.1 per cent after 2002. Simulation results show no significant, or even noticeable, impacts in other economic sectors.

Bear in mind the conservative assumptions built into the simulation estimates. Affected farm operators are assumed to use only one financial strategy in complying with the proposed rules. No offsets are built into the simulation to take into account increased farm purchases of equipment or services. So the scenario described in the simulation results should be considered as an unlikely, perhaps a "worst case," possibility. When the time comes for farm operators to comply with the proposed rules, they will likely use every opportunity to reduce the costs of compliance. In a very real and practical sense, the financial impact of the proposed rules depends significantly on farm operators and the decisions they make about the timing and efficiency of new expenditures. They will probably make use of all their financial options. Farm operators also will probably schedule facility modifications so that costs are incurred when economic conditions are more favorable than they are now.

Table 12. Simulated Economic and Employment Impacts, Years 2000 to 2002.

	State Total	Dairy	Hogs	Poultry	Cattle
Decreased Economic Output (Thousands of Dollars)					
Direct Effects	$4,210	$1,790	$1,540	$80	$800
Indirect Effects	$2,446	$11	$398	$2	$120
Induced Effects	$1,333	$3	$3	$5	$3
Total Effects	$7,989	$1,804	$1,941	$88	$924
Percent of Total Output	0.00%	0.13%	0.17%	0.01%	0.18%
Decreased Employment (Percent) [1]					
Direct Effects	28.0	8.0	17.0	0.0	3.0
Indirect Effects	23.0	0.0	4.0	0.0	1.0
Induced Effects	18.0	0.0	0.0	0.0	0.0
Total Effects	69.0	8.0	21.0	0.0	4.0
Percent of Total Employment	0.00%	0.12%	0.15%	0.00%	0.18%

[1]Percentages are based on totals in Table 9.

Market Conditions

Recall the short discussion about mathematical models that ended the Introduction in Section A. Models should be used when they are needed, but their results usually should not be taken as final answers to detailed questions. The IMPLAN simulation results are needed to provide a general context for evaluation of the economic impacts that may result when a few sectors incur regulatory compliance costs. However, the model cannot give us a completely accurate picture of likely future economic impacts because the model relies on limited data. IMPLAN's estimates are based on 1996 data. None of the economic changes that have occurred since 1996 are taken into account in IMPLAN.

Table 13. Simulated Economic and Employment Impacts, Years 2003 and Beyond.

	State Total	Dairy	Hogs	Poultry	Cattle
Decreased Economic Output (Thousands of Dollars)					
Direct Effects	$1,240	$340	$750	$20	$130
Indirect Effects	$804	$4	$194	$0	$19
Induced Effects	$368	$1	$1	$1	$1
Total Effects	$2,412	$345	$945	$21	$150
Percent of Total Output	0.00%	0.03%	0.08%	0.00%	0.03%
Decreased Employment (Percent) [1]					
Direct Effects	10.0	2.0	8.0	0.0	1.0
Indirect Effects	8.0	0.0	2.0	0.0	0.0
Induced Effects	5.0	0.0	0.0	0.0	0.0
Total Effects	23.0	2.0	10.0	0.0	1.0
Percent of Total Employment	0.00%	0.03%	0.07%	0.00%	0.05%

[1]Percentages are based on totals in Table 9.

Agriculture is undergoing structural changes, both in Minnesota and throughout the United States. "Structural change" means that the numbers, sizes and types of firms in an economic sector are changing more rapidly than is usual. It is important to remember that nearly all economic systems are dynamic. Business firm numbers and sizes change constantly. Some firms grow, even during recessions, and some firms decline, even during economic expansions. The feature to note about current conditions in the agricultural economy is that the pace of structural change has increased in recent years.

Changes in our regional and national farm economies now have the attention of hundreds of researchers, business firms and government agencies. This short review of agricultural market conditions covers material compiled by:

- A literature review prepared for the Environmental Quality Board's generic environmental impact statement (GEIS) on animal agriculture;
- A January 1999 program evaluation report on the MPCA's feedlot programs – the report was prepared by the Office of the Legislative Auditor;
- The US Department of Agriculture's Economic Research Service;
- The Minnesota State Colleges and Universities' Farm Business Management program and its regional farm business management associations;
- Reports from the University of Minnesota's Applied Economics department; and
- Reports from the Kansas City Federal Reserve Bank's Center for the Study of Rural America.

Readers, who want to study agricultural market conditions in more detail may find these sources useful, particularly the literature reviews for the GEIS.

Popular media report that up to eight per cent of Minnesota farms may go out of business within the next year (St. Paul Pioneer Press, October 24, 1999). Researchers, policy makers and business representatives suggest a variety of factors as the reasons for change in agricultural sectors:

- Low prices for agricultural commodities;
- Technological change;
- Foreign competition;
- Low foreign demand for American agricultural commodities;
- Federal and state agricultural policy;
- Federal trade policy;
- Monopolistic practices; and
- Vertical integration (manufacturers' control of input suppliers or output buyers) of food processing firms.

There is considerable dispute about which factors have the greatest impact. Debaters sometimes disagree on whether influences are positive or negative (e.g., the effects of technological change). Some researchers have taken a closer look at economic effects caused by factors comparable to the subject of specific concern in this SONAR: environmental regulations. The Environmental Quality Board's GEIS literature review cites studies that have tested to find out how agricultural production markets respond to environmental regulations.

One set of studies, cited in the GEIS literature review, compared growth in hog inventories in thirteen states from 1988 to 1995.[2] Differences in states' environmental regulations were among the independent factors included in the tests. Findings were mixed – some regulatory factors or indexes were related to growth, but other regulatory factors were not related to growth.

Another study cited in the GEIS literature review (p. D/E-58) compiled hog industry statistics from a number of sources and commented on noticeable relationships.[3] The study concluded that environmental regulations influence facility location decisions. No empirical tests were included in this study.

An empirical study of dairy farm budgets, cited in the GEIS literature review, found that the size of a dairy operation affected a firm's ability to comply with federal environmental regulations:

Moderate size dairies were found to be affected more adversely by being required to meet the specified Region VI EPA regulations than large size dairies. Dairies that were already in financial trouble could be put out of business by requirements to conform with the Region VI EPA standards. Many of these dairies, however, could go out of business regardless of the EPA requirements, albeit at a later date.

Large scale dairies that were not already in financial trouble appear to be able to amortize the extra capital investment costs associated with meeting the Region VI EPA requirements. This suggests that moderate size dairies faced with needing to make investments to meet the EPA standards may choose to expand the scope of their operations, if financially able. While such expansion would require an even larger investment, it also would hold the potential for making the dairy more efficient and competitive.

The GEIS literature review concluded:

> We could find few published empirical analyses of the cost of livestock operations' compliance with environmental regulations. One reason for the dearth of work on this area may be that the regulations are evolving so rapidly and vary so much across localities and farm types. It is difficult to arrive at a small number of representative farm situations

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[2] Mo, Y, Abdalla CW, 1988. "Analysis of Swine Industry Expansion in the US: The Effect of Environmental Regulation," Staff Paper 316. Department of Agricultural Economics and Rural Sociology, Pennsylvania State University.
and
Mo, Y, Abdalla CW, 1988. "Analysis Finds Swine Expansion Driven Most by Economic Factors," Feedstuffs: 20
both studies cited in the Environmental Quality Board's GEIS literature review, p. DE-57.
[3] Drabenstott, M, 1998. "This Little Piggy Went to Market: Will the New Pork Industry Call the Heartland Home?" Economic Review of the Federal Reserve Bank of Kansas City. cited in the Environmental Quality Board's GEIS literature review, p. DE-57.

> that can be analyzed to provide results that are able to generalize the range of farm situations that are out there, and that will stay relevant into the future. (p. D/E-59).

Findings reported in the Environmental Quality Board's GEIS literature review tend to agree with the results of the IMPLAN model simulation. Environmental regulations may, under some conditions, have a significant impact on livestock operations. But empirical studies do not provide strong support for estimates of the extent of any economic impacts. Factors besides environmental regulations are proving to be more influential in determining the scope and pace of economic change in the agricultural sectors of the economy.

Conclusion of Modeling and Literature Analysis of Economic Impacts

Implementing the proposed feedlot rules will probably not have a significant impact on Minnesota's general economy. This conclusion is supported by simulation analysis that is based on a regional economic model and by a review of expert opinion in the GEIS literature review.

Other conclusions are less definite. Findings based on the simulation model show that economic impacts could be significant in some agricultural sectors, if farm operators cannot or do not take advantage of cost-minimizing financial options. Simulation analysis also indicates that some agricultural sectors will likely incur noticeable economic impacts (i.e., a change in output or employment greater than 0.1 per cent), but the specific extent of these impacts is indeterminate because they depend on the timing and direction of market developments. That is, farm operators are expected to wait for favorable economic conditions before they take steps to comply with the proposed rules. Farmers' financing choices are unpredictable now, but they will have a significant effect on the costs incurred and the economic impacts that result.

A survey of expert opinion, compiled in the GEIS literature review, indicates that structural changes are underway which will likely cause continued decrease in the number of livestock farms. General market forces are the strongest current influences on the structure of agricultural sectors. Empirical evidence is mixed with respect to the effects of environmental regulations on agricultural market structure.

The proposed rules will impose costs on some farm operators and the burden may prove too large for some operators to bear. However, the likeliest scenario will show slight declines in output and employment in directly affected sectors, without significant losses in agricultural or other sectors. This conclusion is based on: a) interpretation of a simulation introduced into an economic model and b) a review of relevant parts of the GEIS literature review.

C. Comparison of Costs: Current Versus Proposed Requirements

A scenario illustrating the costs of the current requirements as compared to the cost of the proposed requirements has been included below. Additional scenarios are included as an Exhibit (E-2). The scenarios are based on situations similar to what MPCA staff have experienced when conducting field inspections, but are fictional. When calculating costs for activities that require facility owner labor, the hourly rate of $8 is used. MPCA staff understand that hourly rates realized by individual facility owners vary greatly. However, a value was needed to represent costs incurred when the rules require facility owners to complete an activity. The $8 hourly rate was determined by using the net farm income of $15,754 from 1998 as reported in the 1999 Minnesota Agricultural Statistics, page 15 (Exhibit E-3). The net income was used instead of the gross farm income because farm owners pay many farm expenses, such as labor, from the gross receipts and therefore the gross income would be inflated compared to the actually hourly rate realized by the facility includes both crop and livestock facilities. This also influences the annual net income value. However, most livestock facilities also have crop production.

Scenario 1: John Deere currently owns a 125 head dairy facility (175 animal units) that is located outside of any restricted areas according to rule part 7020.2005, as proposed. John's facility has an open lot with a runoff problem and an earthen basin. John owns 500 acres of cropland on which he land applies manure produced from the dairy facility. John has never received a permit or certificate of compliance for his operation from the MPCA or delegated county.

Table 14: Economic Impact Scenario Number 1: 125 Head (175 Animal Unit) Dairy Facility.

Issue	Runoff Problem to Surface Water	Unpermitted Earthen Basin
Current Rule Parts	Potential pollution hazard, part 7020.0300, subp. 20.	Unpermitted manure storage basin and reconstruction required. Rule violation; part 7020.0400, subp. 1, prohibits construction of manure storage area without a permit or certificate of compliance.
Proposed Rule Parts	Pollution hazard, part 7020.0300, subp. 19a, extension for compliance with water quality standards, part 7020.2003, subp. 4.	Part 7020.2110, subp. 3.
Current Require-ments	Apply for an interim permit. Permit will require submittal of plans for corrective measures, once plans are submitted then an Interim A permit is issued. Permit requires installation of corrective measures within 10 months.	Potential pollution hazard because will allow seepage into groundwater. Interim permit and fix within 10 month required.

Issue	Runoff Problem to Surface Water	Unpermitted Earthen Basin
Costs for Current Require-ments	6 hours @ $8 = $48 + *$5 for county copies + $3,000 installation of corrective measures = $3,053 2 hours to complete permit application form. Soil conditions (review soil survey manual) Hydrogeologic conditions (only required for earthen basin installation) Map or aerial photos (*copy from County office) 2 hours to prepare manure management plan (assistance available from MN Extension Service or possibly county office) 2 hours to prepare plans for roof gutters and diversions as corrective measures. $3,000 to installation of roof gutters (130 feet gutters @ $20 per foot = $2,400) and diversions (300 feet @ $2 per foot = $600) for corrective measures.	No additional costs to acquire interim permit because unpermitted basin would be included in interim permit for runoff problems. $38,000 Replace existing manure storage area (cost for Soil lined storage pond 176 animal units constructed in 1995 from page 2 of Exhibit E-1.)
Proposed Require-ments	Apply for an interim permit. Submit plans for corrective measures. Permit requires installation of corrective measures within 24 months. Submit a certification accepting the 2003/2009 deadlines for correcting his open lot runoff problem and complies with these deadlines Follows technical standards such as developing manure management plan and retain it on site. Perform manure and soil testing in accordance with manure management requirements	Comply with the unpermitted basin requirements by 2003

Issue	Runoff Problem to Surface Water	Unpermitted Earthen Basin
Costs for Proposed Require-ments	2.5 hours @ $8 + $3,000 installation of corrective measures = $3,037 0.5 hour to complete facility registration form and certification form. 2 hours to prepare plans for roof gutters and diversions as corrective measures. $3,000 to installation of roof gutters and diversions.	$38,000 Replace existing manure storage area (Cost for Soil lined storage pond 176 animal units constructed in 1995 from page 2 of Exhibit E-1.) $1,000 cost for soil investigation conducted by design engineer
Estimated Cost Difference from Current Rules and Proposed Rules	Slight cost savings in owner time because a permit application is not required. In addition, the owner has nearly 3 years to plan the most beneficial financing for the $3,000 corrective measure cost. The current rule requires measures for planning corrective measures to begin immediately. Part 7020.2003, subp. 4, as proposed, requires the corrective measure to be made by October 1, 2003. Costs for preparing manure management plan are delayed until October 1, 2005.	$1000 cost increase due to proposed rules requiring a soil investigation conducted by a design engineer

D. Estimated Cost to Correct Pollution Problems at all Existing Facilities not yet in Compliance

As discussed in the Statement of Need, many existing animal feedlots in Minnesota are not yet in compliance with the water pollution effluent limits for animal feedlots set forth in Part 7050.0215. These limitations are based on the Minn. stat. sec. 115.01, subd. 13, pollution of waters, and Minn. stat. sec. 116.06, subd. 14, land pollution. The proposed rules do not change these standards or the applicability of these standards. The proposed rules delay for some facilities the date on which compliance with these standards must be demonstrated. For these reasons, the proposed rules either reduce or have no impact on the cost of complying with the effluent limitations currently in Minnesota Rules. For reasons of completeness and transparency, this portion of this Statement of Need and Reasonableness will discuss the estimated cost to bring all animal feedlots into compliance with the effluent limitations in Minnesota Rules.

Based on staff experience and the fact that until recently the vast majority of livestock facilities had fewer than 300 animal units, the agency believes that the majority of the facilities that remain out-of-compliance with the effluent limitations have fewer than 300 animal units. Staff experience indicates that as many as 20 to 40 percent of the facilities (8,000 to 12,000) with fewer than 300 animal units could have open lots and runoff from these lots in excess of the effluent limitations in part 7050.0215. The estimated cost to bring all animal feedlots in Minnesota into compliance with the effluent limitations is therefore based on the assumption that the vast majority of this cost is the cost to bring those facilities with fewer than 300 animal units with open lot runoff into compliance.

It is very difficult to estimate the economic cost to bring all of the livestock facilities that are currently not in compliance with the effluent limitations into compliance. The data available from which to estimate projected costs is limited. These estimates were derived using the best available data and supplementing professional judgments wherever data is lacking. All values were derived using estimates that were based on what MPCA staff believe are "worst case" scenarios.

To estimate the costs that are likely to be incurred by Minnesota livestock owners or operators to come into compliance with the effluent limitations, the analysis was conducted by dividing the industry into sectors. A summary of these estimated cost is provided in Table 15.

Cattle and Calve Facilities

The 1997 census of Agriculture (Exhibit E-3) estimates that Minnesota has approximately 30,913 farms in Minnesota that have cattle and calves as a component of their operations. The census states that there are approximately 15,745 beef cow operations and 9,603 milking cow operations. Therefore, of the 30,913 farms with cattle and calves, there are an estimated 5,565 facilities where we are unable to determine if they are included in the dairy sector or beef sector. Assuming that the 5,565 are of the same distribution as the 25,348 that are accounted for, 3,457 are beef cow operations and 2,108 are milking cow operations. Therefore, there are an estimated 19,202 beef and 11,711 milking cow operations in Minnesota.

Dairy Sector

The MPCA database indicates that approximately 96% (11,243) of dairy facilities in Minnesota have fewer than 300 animal units. Assuming that 20 to 40 percent of these facilities are not yet in compliance with the effluent limitations, 2,249 to 4,497 dairy facilities have runoff problems that will require capital expenditures to correct existing problems.

A summary of the past 5 years of Natural Resource Conservation service projects at dairy facilities gives and estimated average cost per dairy farm needing fixing at $36,000 (Exhibit E-1). Assuming that this is the cost bring each of the facilities into compliance with the effluent limitations as required by both current and proposed rules, the estimated cost to bring the dairy sector into compliance with the effluent limitations is $81 to $161.9 million.

Beef Sector

The 1997 census of agriculture estimates that there are approximately 19,202 beef cattle operations in the state of Minnesota. Of these 19,202 sites, MPCA data estimates that 90% (17,282) of these have fewer than 300 animal units. Assuming that 20 to 40 percent of these facilities are not yet in compliance with the effluent limitations, 3,457 to 6,913 beef facilities have runoff problems that will require capital expenditures to correct existing problems.

A summary of the past 5 years of Natural Resource Conservation service projects at dairy facilities gives and estimated average cost per beef farm needing fixing at $19,000 (Exhibit E-1). Assuming that this is the cost bring each of the facilities into compliance with the effluent limitations as required by both current and proposed rules, the estimated cost to bring the beef sector into compliance with the effluent limitations is $65.7 to $131.3 million.

Swine Sector

The 1997 Census of agriculture estimates that Minnesota has 7,512 hog and pig farms. Review of the MPCA database indicates that approximately 12% of hog facilities have open lots without runoff controls. Assuming that 12 percent of these facilities are not yet in compliance with the effluent limitations, 901 swine facilities have runoff problems that will require capital expenditures to correct existing problems.

A summary of the past 5 years of Natural Resource Conservation service projects at swine facilities gives and estimated average cost per swine facility at $43,000 (Exhibit E-1). Assuming that this is the cost bring each of an estimated 901 facilities into compliance with the effluent limitations as required by both current and proposed rules, the estimated cost to bring the swine sector into compliance with the effluent limitations is $38.8 million.

Table 15. Summary of Cost Estimates for Correcting Problems at all Existing Facilities not yet in Compliance.

Economic Sector	Number of Existing Facilities[1]	Number of Existing Facilities Potentially Impacted	Total Estimated Cost of Compliance (Millions of Dollars)
Diary	11,711	2,250 to 4,500	81 to 162
Beef	19,202	3,450 to 6,900	66 to 131
Swine	7,512	900	39
Poultry	3,189	Insignificant	Insignificant
Total	41,614	6,600 to 12,300	186 to 332

[1]According to the 1997 Censuses of Agriculture

Poultry Sector

Most modern poultry facilities are total confinement and therefore are not likely to have runoff problems that will require capital expenditures to correct existing problems. Therefore we are assuming there will be little or no cost for this sector for runoff from existing facilities.

Other Sectors

The agency estimates that the number of facilities in other sectors (e.g., horses, sheep and non-traditional animal types) needing corrective measures is insignificant relative to the numbers of facilities in the major livestock sectors. Therefore, the agency has not estimated the costs to correct problems at these existing facilities.

Summary of Cost to Comply with Current Effluent Limitations

The proposed rules do not increase the cost of complying with the effluent limitation. The effective implementation of the program plan with an increase in field presence will result in more facilities incurring cost to come into compliance with the current effluent limits. As stated in the Reasonableness as a Whole section of this document, a major goal of the proposed rules is to minimize the impact of these expenditures by allowing owners of the largest group of noncompliant facilities (fewer than 300 animal units with runoff from an open lot) to come into compliance over the next nine years.

The proposed rules require all animal feedlots and manure storage areas to be included in a county's Level 2 inventory that has been submitted to the agency or register with the agency. The information gathered by the agency will allow the agency to determine a better estimate of the total cost of complying with the effluent limitation.

VI. ADDITIONAL NOTICE

The formal rule revision process began in early 1995. The first notice of solicitation for public comment was published in June of 1995. Three subsequent notices of solicitation were published; the final one in August of 1998. Beginning in December of 1995, MPCA rule revision staff began meeting regularly with the chief advisory committees as well as other major interest groups. Of the groups, Feedlot and Manure Management Advisory Committee (FMMAC), has been the main advisory group. Drafts of revised rules have been presented for discussion in, at least, eight FMMAC meetings in the past three years. Delegated counties' feedlots officers (CFOs) an advisory group that also met frequently. Regional meeting of the CFOs are convened quarterly and rule revision drafts were generally an agenda item at these meetings.

Subcommittees were formed to draft concepts and language for particular areas of the feedlot rules. Subcommittees consisted of a balance of producer, regulatory and environmental interests. Subcommittees that were set up included land application, stockpiling and manure storage committees. In addition, MPCA staff either presented or disseminated draft rule information at major governmental and trade association meetings around the state, including the Association of Minnesota Counties, Association of Minnesota Townships, and the County Attorney Association. Finally, staff met upon request. Among these groups were the Pork Producers Association, the Association of Turkey Growers, the Minnesota Center for Environmental Advocacy, the Dairymen Association, Clean Water Action, and Minnesota Cattlemen

Association. The agency published a rule update four times during the rule-revision period, which was mailed to over 4,500 individuals on an interested party mailing list.

In addition to the efforts made above, the agency has completed addition efforts to involve groups and individuals into the process. These efforts are summarized below.

A. Request for Comments

Four "Request for Comments" periods were conducted during the feedlot rule revision effort. Three of these formal comment periods were conducted in 1995 and one was done in 1998. The agency received approximately 200 comments during the four formal comment periods. Many additional comments on the rules were received by the agency outside of the official comment periods. Agency staff has reviewed these comments and they are maintained on file;

B. Public Informational Meetings

The agency accomplished rule-revision communication, education and outreach by making presentations to a wide-range of interest groups. These meetings began in 1995 and have continued through the rule revision process. See Exhibit O-1. The agency both sponsored meetings and responded to requests for presentations. These meetings were held with livestock producers, producer associations, environmental organizations, county feedlot officers, professional associations, industry consultants, state and federal agencies, and local, state and federal regulators. On many occasions staff met, when requested, with key representatives of potentially affected interests. The agency continues its public information efforts relative to these rules. In November 1999, the agency held eight meetings around the state on the most up-to-date rule draft. The meetings were well attended by all interested parties listed above. The meeting started with a short summary of the rules with one-on-one sessions between staff and interested individuals. See Exhibit O-1.

C. Rule Revision Updates

Staff created a mailing list by selecting organizations determined to have the greatest stake in the rule revision process. Chief constituencies included legislative officials, county regulators, producer groups and environmental organizations. See Exhibit O-2. Additional parties were added to the mailing lists as a result of submitting comments or by request. Four rule updates were prepared and sent to interested parties during the rule revision process. See Exhibit O-3. The updates discussed concepts important to the rule revision, as well as specific rule proposals. The updates were sent to all parties identified on the mailing lists.

D. Feedlot and Manure Management Advisory Committee (FMMAC)

The state feedlot advisory committee known as FMMAC and established by statute was very involved in the rule amendment process. There were particularly involved from May to October 1999 in working towards the final proposed rule. See Exhibit O-4. This included a land application taskforce, a manure storage construction taskforce, a stockpiling taskforce, and a county delegation taskforce.

VII. IMPACT ON FARMING OPERATIONS

Minn. Stat. § 14.111 (1995) requires an agency to provide a copy of the proposed rule changes to the commissioner of agriculture no later than 30 days prior to publication of the proposed rule in the State Register. A copy of the proposed rule was sent to Commissioner Hugoson on November 19, 1999, with a cover letter explaining this rulemaking in light of agricultural operations. See Exhibit G-5. In addition, the agency sent a copy of the proposed rule to Carol Milligan, Department of Agriculture contact for other state agency rule review, on November 19, 1999, to allow her the opportunity to review the documents and make a determination of the rule's impact on farming operations.

In drafting this rule, MPCA worked closely with the Department of Agriculture management and staff. Department of Agriculture has staff on FMMAC and they attended all FMMAC meetings over the past four years that were held on the proposed rule. In addition, Department of Agriculture staff met frequently with the MPCA rule team and management on various rule topics and issues over the past four years, and the suggestions they provided helped shape the final proposed rule.

Overall, the proposed rule will have a significant impact on the livestock and poultry industry in Minnesota. Minnesota is among the top five states in turkey, hog and milk production and the livestock industry totals over $4 billion in cash receipts. The MPCA is the principal agency responsible for regulating the feedlots that contain the turkeys, hogs and livestock in Minnesota, and at last estimate, there were 45,000 farms with feedlots. Thus, the proposed feedlot rules, with their main purpose being to protect Minnesota citizens and Minnesota's lakes, streams, wetlands and/or drinking water sources from the pollution caused by animal manure, will have extensive and wide-ranging agricultural impacts.

VIII. COMMISSIONER OF FINANCE REVIEW OF CHARGES

As required by Minn. Stat. § 16A.1285, the Commissioner of Finance has reviewed the charges proposed in this rule. The Commissioner of Finance's comments and recommendations are attached. See Exhibit F-4.

The agency is proposing under Minn. R. pt. 7002.0270, item F, to clarify that annual fees will only be charged for NPDES permits and SDS permits that regulate animal feedlots and manure storage areas with 1,000 or more animal unit capacity. The proposed rule changes will not establish a new fee rate or increase existing fee rates and will not have a revenue impact. The agency requested the Commissioner of Finance to review the proposed rules in accordance with Minn. stat. § 16A.1285. See Exhibit F-4 for the Commissioner of Finance's response.

Fee rule changes are being proposed as part of the agency's effort to re-design the regulatory program for animal feedlots, manure storage areas and pastures.

The agency is proposing to add item F under Minn. R. pt. 7002.0270 to clarify permit fees as they correspond to the proposed re-structured permit requirements. The agency is proposing no fee changes for National Pollutant Discharge Elimination System (NPDES) and Interim permits. The re-design of the permit system will establish a new permit tool, the Construction Short-form permit and the agency is proposing no fees for this permit. Lastly, the agency proposes to clarify how the fees already established under Minn. R. pt. 7002.0310 for State Disposal System (SDS) permits will be applied under the proposed permit system.

The agency proposes to require some facility owners to have SDS permits. The SDS permit is an agency permit tool established under Minn. R. ch. 7001. However, this permit is not currently required under Minn. R. ch. 7020 and has been rarely used to regulate feedlot and manure storage facilities. Now that the SDS permit will be part of the permit requirements under Minn. R. ch. 7020, the agency believes it to be reasonable to clarify how the existing fees for these permits will be charged for SDS permits that regulate animal feedlots, manure storage areas and pastures. The fees are currently charged for SDS permits that regulate other water quality issues.

The agency is proposing that fees be charged for permits that regulate facilities with 1,000 or more animal units because they will be regulated under an operating permit. An operating permit is required for the life of the facility compared to permits issued for a short term that address construction projects or site specific problems. The agency anticipates that most, if not all, of these facilities will be required to have an NPDES permit and therefore, be required to pay fees as required under the current program. However, if a facility with 1,000 or more animal units is determined not to meet the federal requirement to have an NPDES permit, the agency proposes to require an SDS operating permit and charge the same fee that is currently being charged for the NPDES permit. The agency anticipates that it will be the rare exception to issue a facility in the 1,000 or more animal unit category an SDS permit instead of an NPDES permit. However, the fee for the SDS permit is needed to treat the facilities within this animal unit category the same and to prevent creating an administrative problem for the program. The agency believes it is reasonable to require similar fees because the review and administrative efforts are equivalent between an NPDES permit and an SDS permit.

NPDES permits issued to regulate animal feedlots and manure storage areas are currently charged the application and annual fees under Minn. R. pt. 7002.0310, subp. 2, item B, under the category "Other Non-municipal (any flow)" ($85 application fee and $1,230 annual fee) and subp. 3, under the category "general" ($85 application fee and $260 annual fee). Subpart 2, "Nonmajor NPDES and state disposal permit fees," is used to calculate fees for these permits because the regulated facilities do not meet the definition of "major NPDES facility" under Minn. R. pt. 7002.0220, subp. 4. Item B, "Nonmunicipal permits" is used to calculate these fees because the regulated facilities do not meet the definition of "municipality," which is addressed under item A. The "Other Non-municipal " category is used because the regulated facilities do not discharge sewage, which is the only other fee type in this permit fee category. Subpart 2 establishes fees for permits tailored to address an individual facility and subpart 3 establishes fees for general permits, which are designed to meet the regulatory needs of a group of facilities with similar environmental concerns.

As established in the part heading, “Nonmajor NPDES and state disposal permit fees,” Minn. R. pt. 7002.0310, subp. 2, establishes fees for SDS permits. Therefore, the agency proposes to charge the fees under subpart 2, item B, and subpart 3 to the SDS operating permits for facilities with 1,000 or more animal units as it currently does for the NPDES permits in this animal unit category. Since applying existing fees in a new way may be considered a “new fee,” the agency proposes to require to begin charging fees for the 1,000 or more animal unit SDS permits after July 2, 2001 to comply with 1999 Minnesota Session Laws chapter 231, sec. 2, subd. 2, and plans to follow the Legislative approval process required for rules developed by the agency under Minn. Stat. § 14.18, subd. 2, to comply with the approval requirement under 1999 Minnesota Session Laws chapter 250, article I, sec. 49.

The agency is proposing to require SDS permits for some facilities with less than 1,000 or more animal units. Most of these facilities will be issued an SDS permit for construction or the correction of a pollution hazard and not be issued an operating permit. Since SDS permits for facilities with less than 1,000 animal units are more similar in scope and duration to the Interim and Construction Short-form permits, the agency is proposing not to charge fees for these permits. Again, it is reasonable that the fee reflect the level of administrative effort expended to issue the permit.

There are approximately 40,000 animal feedlots, manure storage areas, and pastures in Minnesota. This number is an estimate because Minnesota does not currently have a comprehensive inventory of these facilities. The agency anticipates that less then two percent of this total will be assessed state permit fees under the draft rule amendments. However, most, if not all, of these fees would already be required under the existing feedlot regulatory program. For the purpose of discussing fees, the agency estimates that animal feedlot, manure storage area and pasture facilities are distributed as presented in Table 16.

Table 16. Estimated Number of Existing Facilities Subject to Permit Fees.

Category of facility in animal units	Estimated number of facilities in category	[1]Estimated number required to have an NPDES permit under the current program	[1]Additional number required to pay fees under the proposed rules
0 to 299	32,000	0	0
300 to 999	7,200	40	0
1,000 or more	800	800	0 now [2]

[1] The number of estimated permits represented in columns 3 and 4 are anticipated to be processed and issued over a six year period.
[2] EPA determination finds no NPDES permit required then number added to this column, but subtracted from 3rd column.

IX. NOTIFICATION TO THE COMMISSIONER OF TRANSPORTATION

Minn. Stat. § 174.05 requires the MPCA to notify the Commissioner of Transportation of rulemakings that concern transportation related issues. The Commissioner of Finance's has been notified of these proposed rules by the agency. See Exhibit F-4.

X. LIST OF WITNESSES AND EXHIBITS

A. Witnesses

In support of the need for and reasonableness of the proposed rules, the MPCA anticipates having the witnesses listed below testify at the rulemaking hearings. Along with the names of the individuals who are available to testify are the principal topics on which they would testify.

Ronald Leaf, P.E.: The proposed amendments in general, history of the feedlot program, the permitting program and various technical standards.

David Wall: Land application of manure and karst-related technical standards.

Christopher Lucke, P.E.: Various technical standards and consideration of economic factors.

Robert McCarron: Consideration of economic factors.

Don Hauge: History of this rulemaking effort, the registration program and the delegated county programs.

Mike Mondloch: The proposed amendments in general, the permitting program.

Deborah Olson: Permit fees and rulemaking processes.

Myrna Halbach, P.E.: Feedlot Program Plan, the agency’s efforts in the delegated county program and composting technical standard.

Gary Pulford: Feedlot program coordination with other state agencies and the process and outcomes of agency’s work with the Feedlot and Manure Management Advisory Committee.

Roberta Wirth: Composting and manure stockpiling technical standards.

B. Exhibits

In support of the need for and reasonableness of the proposed rules, the MPCA anticipates that it will place the following Exhibits into the hearing record:

KEY:

A = Need as a Whole
B = Poultry Barn Floors
C = County Program
E = Economics
F = Permit Fees
G = General Information
I = Registration Program
L = Land Application
M = Liquid Manure Storage
O = Outreach
P = Permit Program
S = Stockpiling
T = Technical Standards (misc.)

Exhibit Number	Title
A-1	Generic Environmental Impact Statement on Animal Agriculture: A Summary of the Literature Related to the Effects of Animal Agriculture on Water Resources (G). Mulla, David J. et. al. Prepared for the Environmental Quality Board, September 1999.
A-2	Nitrate in Ground Water - Existing Conditions and Trends, excerpt from Nitrogen In Minnesota Ground Water, pages B-1 to B-70. Prepared by the Legislative Water Commission, December 1991.
A-3	Phosphorus Export Coefficients: and the Reckhow-Simpson Spreadsheet: Use and Application in Routine Assessments of Minnesota Lakes, A Working Paper, Steven Heiskary and Bruce Wilson, Minnesota Pollution Control Agency, November 1994.
A-4	Lake Shaokatan Restoration Project: Final Report, prepared by David J. Schuler, Environmental Engineer for the Yellow Medicine River Watershed District. Received by MPCA on August 20, 1996.
A-5	Surface Water Nitrogen, excerpt from Nitrogen In Minnesota Ground Water, pages E-1 to E-10. Prepared by the Legislative Water Commission, December 1991.
A-6	Potential Health and Environmental Effects of Nitrogen Contaminated Ground Water, excerpt from Nitrogen In Minnesota Ground Water, pages A-6 to A-15. Prepared by the Legislative Water Commission, December 1991.
A-7	Gulf of Mexico Hypoxia Assessment Plan, prepared by Committee on Environment and Natural Resources Hypoxia Work Group, March 1998.
A-8	Cropland: Contributions to Ground Water Nitrogen and Best Management Practices to Reduce Nitrogen Contamination, Chapter G from Nitrogen In Minnesota Ground Water, pages G-1 to G-63. Prepared by the Legislative Water Commission, December 1991.
A-9	Nitrate Concentrations Leaching Below Row-Crops In Minnesota - A Review, prepared by Dave Wall, Minnesota Pollution Control Agency, May 7, 1996, draft.
A-10	Report On Noncommercial Manure Applicator Training and Certification to the 1999 Minnesota Legislature, prepared by the Minnesota Department of Agriculture, Agronomy and Plant Protection Division, January 1999.

Exhibit Number	Title
A-11	Seepage From Earthen Manure Storage Systems, Minnesota Pollution Control Agency fact sheet, July 1997.
A-12	Generic Environmental Impact Statement on Animal Agriculture: A Summary of the Literature Related to Air Quality and Odor (H). Jacobson, Larry D. et. al. Prepared for the Environmental Quality Board, September 1999.
A-13	Code of Federal Regulations, Title 40, Part 412.
A-14	Code of Federal Regulations, Title 40, Section 122.23.
A-15	EPA, FRL-5817-3, Region 10, Notice of Final General Permit for Concentrated Animal Feeding Operations, Comment #1.
A-16	Minnesota Agricultural Statistics, State Rankings: Minnesota's Rank Among States, Michael Hunt, George Howse, Minnesota Agricultural Statistics Service, 1998.
A-17	Minnesota's Nonpoint Source Management Program, Assessment Chapter, Minnesota Pollution Control Agency, 1994.
A-18	Generic Environmental Impact Statement on Animal Agriculture. Prepared for the Environmental Quality Board, September 1999.
B-1	Technical Guidelines for Poultry Barn Floors, Minnesota Pollution Control Agency fact sheet, March 5, 1998.
B-2	A Preliminary Study on Seepage From Deep Bedded and Poultry Liter Systems, J. Zhu, R. V. Morey, D. R. Schmidt and G. Randall, University of Minnesota, August 1999.
B-3	Investigation report: Adequacy of clay as a floor system for poultry barns, Tiry Engineering, M. J. Tiry, P.E., November 23, 1994.
B-4	Example of MPCA interim permit for turkey barn floor construction, MPCA-I 2179(A)R, April 17, 1998.
C-1	MPCA Annual County Feedlot Officer Report examples.
C-2	MPCA Delegated County Feedlot Officers, Minnesota Pollution Control Agency Fact Sheet, November 1997.
C-3	Feedlot Program Activities Involving Interaction Between MPCA and Counties. Minnesota Pollution Control Agency, Draft Fact Sheet, October 22, 1999.
C-4	1995 and 1999 legislative appropriation language for county feedlot grant program. Laws of Minnesota, Chapter 632, Section 3(a), and Laws of Minnesota, Chapter 231, Section 2, Subdivision 2.
C-5	Environmental Quality Board, Generic Environmental Impact Statement on Animal Agriculture: Status of County Conducted Feedlot Inventories in Minnesota, October 4, 1999.

Exhibit Number	Title
C-6	Cass County Environmental Services 1995, 1996 and 1997 MPCA Feedlot Grant Annual Report Examples.
C-7	Minnesota Center for Environmental Advocacy compilation of responses to county feedlot officer survey.
E-1	Minnesota Natural Resources Conservation Service project summary for 1994 to 1997. Expert opinion on runoff control system costs: E-mail from Mr. Mark Gernes, Winona County, Minnesota to Mr. Don Hauge, Minnesota Pollution Control Agency, October 1, 1999, 1:15 PM; Letter from Mr. Robert Romocki Natural Resources Conservation Service to Mr. Ron Leaf, Minnesota Pollution Control Agency, March 24, 1999; Fax from University of Minnesota Extension Service, Wabasha County to Mr. Ron Leaf, Minnesota Pollution Control Agency, March 25, 1999, 1:33 PM.
E-2	Additional Example Economic Impact Scenarios.
E-3	1997 Census of Agriculture – State Data, Table 1, United States Department of Agriculture, National Agricultural Statistics Service, 1997.
E-4	AGWASTE database data on permitted facilities. Minnesota Pollution Control Agency. Is there a date for this data? Under what rule or authority do we collect this data? Not used.
E-5	Graph of Baseline Versus Simulation Forecast.
E-6	Manure Management Plan for Dick Bergland, producer, Manure Application Planner, Version 2.0, April 1995.
E-7	The Advantage of Manure, Stanley Burman, Agren, Inc. Paper presented at the manure management conference, hosted by the West North Central Region of the Soil and Water Conservation Society on February 10 – 12, 1998, Ames, Iowa. Paper published in Extended Abstracts of Papers and Posters Presented, Manure Management , In Harmony with the Environment and Society.
E-8	Case Study: Economic Impact of Restricting Phosphorus Fertilization on a Minnesota Dairy, J. G. Schimmel, R. A. Levins, Z. Vincze, University of Minnesota Extension Service, and Minnesota Pollution Control Agency. Paper presented at the manure management conference, hosted by the West North Central Region of the Soil and Water Conservation Society on February 10 – 12, 1998, Ames, Iowa. Paper published in Extended Abstracts of Papers and Posters Presented, Manure Management , In Harmony with the Environment and Society.

Exhibit Number	Title
E-9	Economies of Scales in Swine Manure Utilization; Raymond E. Massey, John A. Lory, John Hoehne, Charles Fulhage, University of Missouri; Paper presented at the manure management conference, hosted by the West North Central Region of the Soil and Water Conservation Society on February 10 – 12, 1998, Ames, Iowa. Paper published in Extended Abstracts of Papers and Posters Presented, Manure Management , In Harmony with the Environment and Society.
E-10	Manure Spreading Costs, Peter Wright, Cornell Cooperative Extension; Paper presented at the manure management conference, hosted by the West North Central Region of the Soil and Water Conservation Society on February 10 – 12, 1998, Ames, Iowa. Paper published in Extended Abstracts of Papers and Posters Presented, Manure Management , In Harmony with the Environment and Society.
E-11	Bartz, Carrie, Email from Carrie Bartz, Minnesota Pollution Control Agency to Paul Trapp Minnesota Pollution Control Agency regarding the estimate number of animal feedlots within 1,000 meters of a lake.
E-12	Swanson, Scott L., Email from Kim Brynildson, Minnesota Pollution Control Agency to Randy Ellingboe, Minnesota Pollution Control Agency regarding Mr. Swanson's (U. S. Department of Agriculture) estimated cost of fencing.
F-1	Manure Production Table form Midwest Planning Service, MWPS-18 manual.
F-2	FY99 Legislative Budget Initiative -- Animal Feedlot Fees.
F-3	Four laws are important to the proposed fee discussion: 1) Minnesota Statutes section 116.07, subdivision 4d. 2) 1999 Minnesota Session Laws chapter 231, section 2, subdivision 2. 3) 1999 Minnesota Session Laws chapter 250, Article I, section 49. Minnesota Statutes section 14.18, subdivision 2. Minnesota Statutes section 16A.1285
F-4	Department of Finance Comments and Recommendations.
G-1	Animal Feedlot Regulation: A Program Evaluation Report, prepared by the Office of the Legislative Auditor, January 1999.
G-2	United States Department of Agriculture, United States Environmental Protection Agency, Unified National Strategy for Animal Feeding Operations, March 9, 1999; and January 14, 1999, response letter from Gene Hugoson, Commissioner of Minnesota Department of Agriculture, Lisa Thorvig, Acting Commissioner of Minnesota Pollution Control Agency, and Ron Harnack, Executive Director of Minnesota Board of Water and Soil Resources. March 9, 1999.
G-3	Feedlot Air Quality Summary: Data Collection, Enforcement and Program Development, produced by Minnesota Pollution Control Agency, March 1999.

Exhibit Number	Title
G-4	Letter from Governor Jesse Ventura to Speaker Sviggum regarding legislation veto, May 25, 1999.
G-5	Letter from MPCA Commissioner Karen A. Studders to MDA Commissioner Eugene Hugoson Regarding Notification of Draft Feedlot Rules That Potentially Affect Farming Operations, November 17, 1999.
I-1	Feedlot Inventory Guidebook, prepared by the Minnesota Board of Water and Soil Resources. June 1991.
I-2	June 14 and August 16 Feedlot and Manure Management Advisory Committee, MPCA staff meeting minutes.
I-3	DRAFT Registration form examples: Level II inventory model and self-evaluation model, Minnesota Pollution Control Agency.
I-4	DRAFT Animal Feedlot Program Plan, Minnesota Pollution Control Agency, August 25, 1999.
I-5	Letters for FMMAC meeting dates April 5, 1999; May 6, 1999; May 26, 1999; June 10, 1999; June 14, 1999; and August 16, 1999.
L-1	Guidelines: Land Application of Manure for Water Quality Protection, Minnesota Pollution Control Agency, June 1996.
L-2	Basis and Justification for Minnesota Land Application of Manure Guidelines, written by Minnesota Pollution Control Agency staff Dave Wall and Gregory Johnson in association with the FMMAC Minnesota Land Application of Manure Task Force, June 1996.
L-3	Land Application of Manure Task Force: Report to the Feedlot and Manure Management Advisory Committee Regarding Proposed MPCA Rule Revision Recommendations for Manure Application, Draft July 1, 1997.
L-4	Minnesota Rules part 7050.0210, General Standards for Dischargers to Waters of the State.
L-5	Agricultural Phosphorus and Eutrophication: A Symposium Overview, Daniel, T.C., Sharpley, A. N., and Lemunyon, J. L., Journal of Environmental Quality, 27:251-257, 1998.
L-6	Livestock Manure Sampling and Testing, Wagar, Tim; Schmitt, Mike; Clanton, Chuck; and Bergsrud, Fred. University of Minnesota Extension Service, FO-6423-B, 1994.
L-7	Fertilizer Recommendations for Agronomic Crops in Minnesota. Rehm, George; Schmitt, Michael; and Munter, Robert. University of Minnesota Extension Service, Bu-6240-E, 1995.

Exhibit Number	Title
L-8	Manure Management in Minnesota. Schmitt, Michael A. University of Minnesota Extension Service,FO-3553-C, 1999.
L-9	Hydrologic Controls of Phosphorus loss from Upland Agricultural Watersheds. Gburek, William J. and Sharpley, Andrew N.; Journal of Environmental Quality, 27:267-277, 1998.
L-10	Agronomic and Environmental Management of Phosphorus. Rehm, George; Lamb, John; Schmitt, Michael; Randall, Gyles; and Busman, Lowell. University of Minnesota Extension Service, FO-6797-B, 1997.
L-11	The Nature of Phosphorus in Soils. Busman, Lowell; Lamb, John; Randall, Gyles, Rehm, George; and Schmitt, Michael. University of Minnesota Extension Service, FO-6795-B, 1977.
L-12	Using the Soil Nitrate Test in Minnesota. Rehm, George; Schmitt, Michael; and Eliason, Roger. University of Minnesota Extension Service,FO-7310-B, 1999.
L-13	Variability of Manure Nutrient Content and Impact on Manure Sampling Protocol. Conference Proceedings from Animal Production Systems and the Environment. Iverson, Kirk V.; Davis, Jessica G.; and Vigil, Merle F.. Colorado State University and USDA-ARS Great Plains Research Station. 1998.
L-14	Minnesota Department of Agriculture. Nutrient Management Assessment Program,
L-15	Developing a Manure Management Plan. Busch, Dennis; Busman, Lowell; and Nesse, Phil. University of Minnesota Extension Service, BU-6957-D, 1997.
L-16	319 Grant Proposal, April 1999. Education to Improve Feedlot, Manure and Nutrient Management.
L-17	Phosphorus Transport to and Availability in Surface Waters. Randall, Gyles; Mulla, Dave; Rehm, George; Busman, Lowell, Lamb, John; and Schmitt, Michael. University of Minnesota Extension Service, FO-6796-B, 1997.
L-18	Phosphorus Loss in Agricultural Drainage: Historical Perspective and Current Research. Sims, J. T., Simard, R. R. and Joern, B. C., Journal of Environmental Quality, 1998.
M-1	Effects of Clay-Lined Manure Storage Systems on Ground Water Quality in Minnesota: A Summary, Dave Wall, Paul Trapp and Randy Ellingboe, Minnesota Pollution Control Agency, February 1998.
M-2	Clay-Lined Earth and Manure Basins, Minnesota Pollution Control Agency, Fact Sheet FS5/2-1/8/97, January 1998.
M-3	Seepage From Earth and Manure Storage Systems, Minnesota Pollution Control Agency, Fact Sheet FS6/1-10/30/97, July 1997.

Exhibit Number	Title
M-4	Animal Manure Storage Pond Evaluation, L. D. Dalen, W. P. Anderson and R. M. Rovang for presentation at the 1983 winter meeting, American Society of Agricultural Engineers, Paper No. 83-4572, December 1983.
M-5	Manure Storage Criteria and Policy Development in Minnesota, J. C. Brach, R. L. Ellingboe and D. Nelson, written for presentation at the 1992 international winter meeting, American Society of Agricultural Engineers, Paper No. 924503, December 1992.
M-6	Solid and Liquid Manure Storage, Engineering Practice EP 393, American Society of Agricultural Engineers, ASAE Standards, 1987.
M-7	MPCA Tightens Earthen Storage Basin Design Requirements, Minnesota Pollution Control Agency News Release, June 3, 1991.
M-8	Recommended Design Criteria for Stabilization Ponds, Minnesota Pollution Control Agency, Fact Sheet, March 1993.
M-9	Waste Storage Facility, Code 313, Minnesota Natural Resources Conservation Service, Conservation Practice Standard, Minnesota Natural Resources Conservation Service, January 1998.
M-10	Recommendations for Testing Prior to Construction, Minnesota Pollution Control Agency, Fact Sheet TG4/1-3-5-98, March 1998.
M-11	Guidelines for Concrete Manure Storage Structures, Minnesota Pollution Control Agency Fact Sheet TG1/1-10/30/97, December 1997.
M-12	Technical Guidance for Ground Water Monitoring at New Feedlots in Minnesota, Minnesota Pollution Control Agency Fact Sheet W4/2-2/3/98, July 1997.
M-13	Manure Storage Systems in the Karst Region: Additional Feedlot Permit Application Requirements, Minnesota Pollution Control Agency Fact Sheet.
M-14	Guidelines for Alternative Liners for Earthen Storage Structures, Minnesota Pollution Control Agency, Fact Sheet TG5/1-10/30/97, December 1996.
M-15	Waste Storage Pond Code 425, Minnesota Soil Conservation Service, Conservation Practice Standard, Minnesota Soil Conservation Service, November 1991.
M-16	Minnesota Pollution Control Agency Contractor's Inspection Record of Manure Pit Construction, Minnesota Pollution Control Agency, Fact Sheet TG2/1-10/30/97, December 1997.
M-17	Minnesota Pollution Control Agency Photographic Inspection of Concrete Manure Storage Pits, Minnesota Pollution Control Agency, Fact Sheet TG3/1-10/30/97, December 1997.

Exhibit Number	Title
M-18	Minnesota Pollution Control Agency Guidelines for Design of Cohesive Soil Liners for Manure Storage Structures, Minnesota Pollution Control Agency Fact Sheet TG6-1/3-5-98, DRAFT February 5, 1998.
M-19	Example of MPCA interim permit for earthen (cohesive-soil) construction, MPCA-I 2464(A), June 24, 1998.
M-20	Clay Liners and Covers for Waste Disposal Facilities, Handout from training presented by University of Texas at Austin, October 28 – 30, 1992.
M-21	Sinkholes and Sinkhole Probability map, County Atlas Series, Atlas C-3, Plate 7 of 9, Sinkhole Probability, Alexander, E. Calvin, Jr., Maki, Geri L. University of Minnesota, Minnesota Geological Survey.
M-22	Health Effects of Drinking Water Contaminants, Water Quality Fact Sheet 2, Stewart, Judith C., Lemley, Ann T., Hogan, Sharon I., Weismiller, Richard A., Cornell University, University of Maryland, Cooperative Extension System.
M-23	Delivery of Nonpoint – Source Phosphorus from Cultivated Mucklands to Lake Ontario, Longabucco, Patricia, and Rafferty, Michael R., Journal of Environmental Quality, 18:157-163, 1989.
M-24	Hygiene of Animal Waste Management, D. Strauch, Animal Production and Environmental Health, Elsevier Science Publishers B. V. 1987.
M-25	The Origin and Identification of Macropores in an Earthen-Lined Dairy Manure Storage Basin, McCurdy, M., McSweeney, K., Journal of Environmental Quality, 22:148-154, 1993.
M-26	Soils Investigations for Feedlot and Manure Storage Facilities, Minnesota Pollution Control Agency, Fact Sheet, July 1997.
M-27	Karst-Aquifers, Caves, and Sinkholes (Plates 8 and 9), Alexander, E. Calvin, and Lively, R. S., Liquid Manure Storage in the Karst Region, Evaluating and Minimizing Risks, Sinkhole Field trip, Lake Louise State Park in Lewiston, Green, Jeffery A. Minnesota Department of Natural Resources, Alexander, E. Calvin, Jr. University of Minnesota , Wall, Dave, Minnesota Pollution control Agency, June 12, 1997.
M-28	Seepage from Animal Waste Lagoons and Storage Ponds – Regulatory and Research Review, Parker, David B., Schulte, Dennis D., Eisenhauer, Dean E., and Nienaber, John A.
M-29	Plugging Effects from Livestock Waste Application on Infiltration and Runoff, Roberts, R. J., Clanton, C. J., Transactions of the American Society of Agricultural Engineers, Vol. 35(2): March – April 1992.

Exhibit Number	Title
M-30	Recommended Standards for Wastewater Facilities, 1997 Edition, Upper Great Lakes –Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, Health Education Services, Health Research, Inc., Albany, NY, 1997.
M-31	High Density Polyethylene Liner Guidelines, Minnesota Pollution Control Agency, January 1988.
M-32	Polyvinyl Chloride Liner Guidelines, Minnesota Pollution Control Agency, June 1990,.
M-33	Pollution Control Guide for Milking Center Wastewater Management; NCR549; Springman, Roger E.; Payer, David C.; Holmes, Brian J. October 1995, North Central Region Extension, Publications Office, Cooperative Extension, University of Minnesota, 3 Coffey Hall, St. Paul, MN 55108.
M-34	An Evaluation System to Rate Feedlot Pollution Potential, United States Department of Agricultural Research Service, ARM-NC-17, April 1982.
O-1	MPCA Feedlot Rule Revision Records of Meetings to Inform Affected Parties. Minnesota Pollution Control Agency.
O-2	MPCA Feedlot Rule Revision Summary of Mailings, Minnesota Pollution Control Agency.
O-3	MPCA Feedlot Rule Updates, Minnesota Pollution Control Agency, July 1996, May 1997, January 1998 and October 1998.
O-4	Feedlot and Manure Management Advisory Committee. Priority Issues, Mr. Charlie Peterson, Minnesota Department of Administration, Summer 1999.
P-1	Guide Manual On NPDES Regulations For Concentrated Animal Feeding Operations, United States Environmental Protection Agency, Final, EPA 833-B-95-001, December 1995.
P-2	Guidance Manual and Example NPDES Permit for CAFOs, United States Environmental Protection Agency, Review Draft, August 6, 1999.
P-3	Memorandum from Mr. Gordon Wegwart, Minnesota Pollution Control Agency to Mr. Gary Pulford, Minnesota Pollution Control Agency regarding Final Case-by-Case Designation Criteria for Concentrated Animal Feeding Operations, October 12, 1999.
P-4	Letter from Mr. Zenas Baer, Baer, Knutson and Associates to Mr. Gary Pulford, Minnesota Pollution Control Agency regarding the feedlot rule making, June 17, 1999.

Exhibit Number	Title
P-5	Letter from Mr. Calvin Covington, American Jersey Cattle Association, National All-Jersey, Inc. to Mr. Ron Leaf, Minnesota Pollution Control Agency, Including four attachments from USDA-ARS (2 attachments), American Society of Animal Science, University of Minnesota Extension Service, November 2, 1999.
P-6	United States Geological Survey (USGS) Quadrangle Maps, Example: Villard Quadrangle, Minnesota, Pope County, 7.5 Minute Series, United States Department of the Interior, Geological Survey, Minnesota Department of Administration, 1968, revised 1979.
P-7	Application for Permit to Discharge Wastewater, Concentrated Animal Feeding Operations and Aquatic Animal Production Facilities, NPDES Form 2B, United States Environmental Protection Agency.
P-8	Minnesota Department of Natural Resources, Protected Waters and Wetland map example. Pope County Minnesota, Revised 1996.
S-1	Soil Nitrogen Concentrations Under Broiler Houses by Kenneth M. Lomax, George W. Malone, Negeda Gedamu, and Anastasia Chirnside, Presented at the June 1995 meeting, American Society of Agricultural Engineers, Paper No. 95 2500.
S-2	Nitrogen Concentrations Under Turkey Barn Floors, by Gary Haberstroh, PE, Water Quality Division, North Dakota Department of Health.
S-3	Nitrogen Barriers for Broiler House Floors by Kenneth M. Lomax, George W. Malone, Anastasia Chirnside, and Negeda Gedamu, June 18, 1995.
S-4	Letter from Mr. Todd Holman, Todd County to Lynn M. Kolze, Minnesota Pollution Control Agency, June 26, 1995.
S-5	Letter from Ms. Roberta Getman, LeSueur County, to Mr. Don Hauge, Minnesota Pollution Control Agency, regarding Requested comments on draft rules for stockpiling, January 29, 1998.
S-6	Letter from George W. Raab, Jerome Foods, Inc., to Mr. Don Hauge, Minnesota Pollution Control Agency, January 19, 1998.
S-7	Stockpile photographs Minnesota Pollution Control Agency
S-8	Fecal Coliform Transport Through Intact Soil Blocks Amended with Poultry Manure, McMurry, S. W.; Coyne, M. S.; and Perfect, E.. Journal of Environmental Quality Vol. 27, 1998.
S-9	Comparison of Waste Strengths According to Oxygen Depletion and Phosphorus Content, Minnesota Pollution Control Agency, Fact Sheet PH3/1-10/30/97, July, 1997.

Exhibit Number	Title
S-10	Composting Methods, On Farm Composting Handbook, Robert Rynk, University of Massachusetts; Maarten Van de Kamp, Massachusetts Dept. of Food and Agriculture; George Willson, George Willson and Associates, Mark Singley, Cook College, Rutgers University; Tom Richard, Cornell University; and John Kolega, University of Connecticut. Northeast Regional Agricultural Engineering Service, Cooperative Extension, Cornell University, June 1992.
S-11	Horticultural Use of Compost: Key Factors to Measure, Carl J. Rosen, University of Minnesota, Presented at Compost Use And Standards: A Wisconsin -Minnesota Composting Conference. October 14, 1999.
S-12	Cattle Feedlot Waste Management Practices for Water and Air Pollution Control, B-1671, Sweeten, John M., Texas Agricultural Extension Service, Texas A&M University System.
S-13	Infiltration of Water on a Cattle Feedlot, Mielke, L.N., and Mazurak, A. P., Transactions of the American Society of Agricultural Engineers, 1976.
S-14	Statistical Analysis of Compost Data: Municipal Solid Waste Compost Utilization Program, Malcolm Pirnie, February 29, 1996.
S-15	40 CFR Part 503 published in the Federal Register on February 19, 1993.
S-16	Statement of Need and Reasonableness for Minn. R. 7035.2836, dated February 23, 1988.
S-17	Minnesota Rules Part 7035.2836.
S-18	United States Department of Agriculture, Natural Resources Conservation Service, Soil Survey of Sibley County, Minnesota, September 1997.
T-1	Heavy Use Area Protection Code 561, Minnesota Natural Resources Conservation Service, Conservation Practice Standard, November 1999.
T-2	Prescribed Grazing Code 528A, Minnesota Natural Resources Conservation Service, Conservation Practice Standard, July 1998.
T-3	National Range and Pasture Handbook, United States Department of Agriculture, Natural Resources Conservation Service, September 1997.
T-4	Interim Permit for the Planning, Construction and Operation of an Animal Feedlot and/or Manure Storage Area, MPCA-I-2519(B), August 21, 1998.
T-5	Unpermitted Earthen Basins, Minnesota Pollution Control Agency, Fact Sheet P7/1-10/30/97, July 1997.
T-6	Filter Strip Code 393B, DRAFT Conservation Practice Standard, Minnesota Natural Resources Conservation Service, September, 1998.

XI. CONCLUSION

Based on the foregoing, the proposed rules are both needed and reasonable.

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Colorectal cancer risk and nitrate exposure through drinking water and diet

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Ingested nitrate leads to the endogenous synthesis of N-nitroso compounds (NOCs), animal carcinogens with limited human evidence. We aimed to evaluate the risk of colorectal cancer (CRC) associated with nitrate exposure in drinking water and diet. A case-control study in Spain and Italy during 2008-2013 was conducted. Hospital-based incident cases and population-based (Spain) or hospital-based (Italy) controls were interviewed on residential history, water consumption since age 18, and dietary information. Long-term waterborne ingested nitrate was derived from routine monitoring records, linked to subjects' residential histories and water consumption habits. Dietary nitrate intake was estimated from food frequency questionnaires and published food composition databases. Odd ratios (OR) were calculated using mixed models with area as random effect, adjusted for CRC risk factors and other covariables. Generalized additive models (GAMs) were used to analyze exposure-response relationships. Interaction with endogenous nitrosation factors and other covariables was also evaluated. In total

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1,869 cases and 3,530 controls were analyzed. Average waterborne ingested nitrate ranged from 3.4 to 19.7 mg/day, among areas. OR (95% CIs) of CRC was 1.49 (1.24, 1.78) for >10 versus $\leq$5 mg/day, overall. Associations were larger among men versus women, and among subjects with high red meat intake. GAMs showed increasing exposure-response relationship among men. Animal-derived dietary nitrate was associated with rectal, but not with colon cancer risk. In conclusion, a positive association between CRC risk and waterborne ingested nitrate is suggested, mainly among subgroups with other risk factors. Heterogeneous effects of nitrate from different sources (water, animal and vegetables) warrant further research.

What's new?
Nitrate ingested in food and water can react with amines and amides in the gastrointestinal tract, leading to the formation of N-nitroso compounds (NOCs), which are carcinogenic in animals. In humans, nitrate and several NOCs are probable carcinogens. The aim of the present investigation, a case–control study in Europe, was to examine links between nitrate intake and colorectal cancer (CRC). The findings indicate that CRC risk is increased for waterborne nitrate intake at levels below current international guidelines, particularly in subgroups with other risk factors. Nitrate intake from animal sources was further associated with increased rectal cancer risk.

Introduction

Nitrate is a widespread contaminant in drinking water due to the overuse of fertilizers in agriculture[1] and urban sewage.[2] Expensive and infrequently used methods such as reverse osmosis are necessary to effectively remove nitrate from drinking water.[3] In addition, nitrate is a main dietary component of vegetables, and an approved food additive for preserved meat, together with nitrite.[4]

Nitrate ingestion through diet and drinking water are the main routes of human exposure. Ingested nitrate is reduced to nitrite, which subsequently reacts with amines and amides to produce N-nitroso compounds (NOCs) in the gastrointestinal system. The intake of vitamins C and E may inhibit endogenous nitrosation, whereas meat intake and chronic gastrointestinal acidic or inflammatory conditions, may increase it.[5] Additionally, exogenous NOCs are ingested through processed meat, canned or cured food, alcohol and tobacco smoking.[6] NOCs are carcinogenic in several animal species,[7] but human evidence is limited, therefore nitrate is classified as probable human carcinogen (group 2A) under conditions resulting in endogenous nitrosation.[8]

Colorectal cancer (CRC) is one of the most frequent cancers worldwide, representing 10% of the global cancer incidence. More than 1 million new cases and 694,000 deaths are registered annually in both sexes.[9] The high intake of energy, red or processed meat[10] and alcohol, as well as physical inactivity and obesity, are established risk factors.[11] Increased CRC risk has been suggested with dietary nitrite[12] or dietary NOCs.[13,14] Recently, a prospective study found an increased risk among subjects with high dietary nitrate and low vitamin C intake.[15] However, few studies have evaluated the risk of CRC associated with nitrate in drinking water. Existing evidence provided by case–control or cohort studies is inconsistent,[5,16] particularly for levels below the current regulatory limit (50 mg/L of nitrate as NO_3^- in the European Union, or 10 mg/L as NO_3-N in the United States),[17] which is a common scenario in high-income countries.

We evaluated the association between CRC risk and the exposure to nitrate through drinking water and diet, taking into account endogenous nitrosation factors and other covariates.

Methods

Study design and population

We pooled data from two case-control studies conducted in Spain (the Spanish Multi-case Control study on Cancer, MCC-Spain)[18] and Italy (part of the European Union Project on Health Impacts of long-term exposure to Disinfection by-products in Drinking Water, HI-WATE),[19] between 2008 and 2013. Study areas comprised eleven provinces (nine from Spain, two from Italy) (see Table 1). CRC cases were identified as soon as possible after the diagnosis through active searches including periodical visits to the hospital departments (*i.e.*, oncology, gastroenterology, general surgery, radiotherapy and pathology). Participant hospitals (17 in Spain, 10 in Italy) were the reference centers for oncologic diseases in each study area. Only CRC cases diagnosed within the recruitment period, with histological confirmation (ICD-10 codes: C18, C19, C20, D01.0, D01.2), without previous cancer history, aged 20-85 years, living in the hospitals' catchment areas, and being able to answer an epidemiological questionnaire, were enrolled. Controls were hospital-based (Italy) or population-based (Spain), and were frequency matched to cases by sex, age and residence area. Hospital-based controls were randomly selected among patients admitted to the same hospitals as cases for acute, non-chronic diseases, unrelated to alcohol, tobacco, dietary habits or to known CRC risk factors (52.2% had acute surgical conditions, 9.0% non-traumatic orthopedic disorders, 6.0% trauma and 32.8% other illnesses). Population-based controls were randomly selected

Table 1. Characteristics of the study population included in the analyses of waterborne ingested nitrate: 1,869 cases of colorectal cancer (1,285 colon and 557 rectum)[1] and 3,530 controls

	Cancer cases				
	Colon n (%)	Rectum n (%)	Colorectal n (%)	Controls n (%)	p values[2]
Study area					
Spain					
Asturias	38 (3.0)	21 (3.8)	59 (3.2)	202 (5.7)	
Barcelona	430 (33.4)	189 (33.9)	629 (33.6)	910 (25.8)	
Cantabria	79 (6.2)	40 (7.2)	119 (6.4)	279 (7.9)	
Gipuzkoa	83 (6.5)	24 (4.3)	107 (5.7)	333 (9.4)	
León	162 (12.6)	77 (13.8)	243 (13.0)	352 (10.0)	
Madrid	143 (11.1)	62 (11.1)	206 (11.0)	658 (18.6)	
Murcia	13 (1.0)	12 (2.2)	25 (1.3)	39 (1.1)	
Navarra	72 (5.6)	24 (4.3)	98 (5.2)	230 (6.5)	
Valencia	52 (4.0)	24 (4.3)	76 (4.1)	131 (3.7)	
Italy					
Milan	118 (9.2)	56 (10.0)	184 (9.8)	270 (7.6)	
Pordenone/Udine	95 (7.4)	28 (5.0)	123 (6.6)	126 (3.6)	<0.001
Sex					
Men	784 (61.0)	382 (68.6)	1,184 (63.4)	1,840 (52.1)	
Female	501 (39.0)	175 (31.4)	685 (36.6)	1,690 (47.9)	<0.001
Age (quartiles)					
≤57 years	226 (17.6)	109 (19.6)	341 (18.2)	947 (26.8)	
58-65 years	294 (22.9)	151 (27.1)	449 (24.0)	870 (24.6)	
66-72 years	335 (26.1)	110 (19.8)	455 (24.3)	833 (23.6)	
>72 years	430 (33.5)	187 (33.6)	624 (33.4)	880 (24.9)	<0.001
Education					
<Primary school	334 (26.0)	147 (26.4)	484 (25.9)	585 (16.6)	
Primary school	478 (37.2)	222 (39.9)	707 (37.8)	1,176 (33.3)	
Secondary school	345 (26.8)	147 (26.4)	505 (27.0)	1,101 (31.2)	
University	128 (10.0)	41 (7.4)	173 (9.3)	668 (18.9)	<0.001
Physical activity (METs hour/week)[3]					
<8 (<8.5)	862 (67.1)	376 (67.5)	1,252 (67.0)	2,266 (64.2)	
8–16 (8.5–34.4)	178 (13.8)	80 (14.4)	266 (14.2)	550 (15.6)	
>16 (>34.4)	245 (19.1)	101 (18.1)	351 (18.8)	714 (20.2)	0.121
Smoking[4]					
Never	549 (43.2)	202 (36.3)	761 (41.0)	1,535 (43.6)	
Ever	723 (56.8)	354 (63.7)	1,093 (59.0)	1,986 (56.4)	0.073
Non-steroidal anti-inflammatory drugs use[4]					
Never	848 (68.4)	371 (68.2)	1,241 (68.6)	2,134 (62.6)	
Ever	391 (31.6)	173 (31.8)	569 (31.4)	1,274 (37.4)	<0.001
Oral contraceptives use[4,5]					
Never	355 (71.1)	124 (72.5)	486 (71.6)	940 (55.9)	
Ever	144 (28.9)	47 (27.5)	193 (28.4)	742 (44.1)	<0.001
Colorectal cancer in first degree relative[4]					
No	1,005 (83.8)	450 (85.6)	1,479 (84.5)	3,065 (91.5)	
Yes	194 (16.2)	76 (14.4)	271 (15.5)	285 (8.5)	<0.001

Table 1. Characteristics of the study population included in the analyses of waterborne ingested nitrate: 1,869 cases of colorectal cancer (1,285 colon and 557 rectum) and 3,530 controls (Continued)

	Cancer cases				
	Colon *n* (%)	Rectum *n* (%)	Colorectal *n* (%)	Controls *n* (%)	*p* values[2]
Body mass index (Kg/m^2)[4]					
≤18.5–24.9	407 (31.7)	194 (34.8)	610 (32.7)	1,338 (37.9)	
25–29.9	585 (45.6)	243 (43.6)	840 (45.0)	1,482 (42.0)	
≥30	292 (22.7)	120 (21.5)	418 (22.4)	707 (20.1)	0.001
Energy intake (kcal/day)[4]					
<1,626	366 (31.7)	132 (26.0)	508 (30.2)	1,058 (33.4)	
>1,626–2,071	341 (29.6)	167 (32.9)	513 (30.4)	1,058 (33.3)	
>2,071	446 (38.7)	208 (41.0)	664 (39.4)	1,057 (33.3)	<0.001
Fiber intake (g/day)[4]					
<17	439 (38.1)	195 (38.5)	646 (38.3)	1,058 (33.4)	
17–23.5	373 (32.4)	156 (30.8)	537 (31.9)	1,058 (33.3)	
>23.5	341 (29.6)	156 (30.8)	502 (29.8)	1,057 (33.3)	0.002
Alcohol intake (g/day)[4]					
≤8	512 (44.4)	217 (42.8)	740 (43.9)	1,615 (50.9)	
>8	641 (55.6)	290 (57.2)	945 (56.1)	1,558 (49.1)	<0.001
Vitamin C (mg/day)[4]					
<117	415 (36.0)	208 (41.0)	634 (37.6)	1,058 (33.4)	
117–186	405 (35.1)	168 (33.1)	583 (34.6)	1,058 (33.3)	
>186	333 (28.9)	131 (25.8)	468 (27.8)	1,057 (33.3)	<0.001
Vitamin E (mg/day)[4]					
<8.5	420 (36.4)	177 (34.9)	603 (35.8)	1,058 (33.4)	
8.5–12.0	382 (33.1)	168 (33.1)	562 (33.4)	1,058 (33.3)	
>12.0	351 (30.4)	162 (32.0)	520 (30.9)	1,057 (33.3)	0.138
Red meat (g/day)[4]					
<20	321 (27.8)	117 (23.1)	444 (26.4)	1,058 (33.4)	
20–40	362 (31.4)	167 (32.9)	537 (31.9)	1,058 (33.3)	
>40	470 (40.8)	223 (44.0)	704 (41.8)	1,057 (33.3)	<0.001
Processed meat (g/day)[4]					
<17	355 (30.8)	132 (26.0)	498 (29.6)	1,058 (33.4)	
17–34	369 (32.0)	148 (29.2)	520 (30.9)	1,058 (33.3)	
>34	429 (37.2)	227 (44.8)	667 (39.6)	1,057 (33.3)	<0.001
Water intake (L/day)					
<0.9	389 (30.3)	185 (33.2)	584 (31.2)	1,181 (33.5)	
≥0.9–1.4	410 (31.9)	167 (30.0)	584 (31.2)	1,209 (34.2)	
>1.4	486 (37.8)	205 (36.8)	701 (37.5)	1,140 (32.3)	0.001

[1]Numbers of colon and rectum cases do not add 1,869 since 27 cases were undefined.
[2]*p values for Chi2 test* comparing controls versus CRC cases, calculated ignoring missing values in covariables.
[3]METs: Metabolic equivalents of task. Categories for physical activity were specific for each country. Cut offs for Italy are between parenthesis.
[4]Numbers do not add total cases and controls because of missing observations.
[5]Descriptive for women.

from administrative records of primary health care centers located within the hospitals' catchment areas in Spain, where universal health coverage is available. Potential participants were contacted telephonically on behalf of their family physician. For each control needed, five potential participants of similar age, and same sex and hospital catchment area were selected. If contact with the first person of the list was not achieved (after at least five attempts at different times of the day), or if he/she refused to participate, the following person of the list was approached.[20] The study protocol was approved by the ethics committees of the participating institutions, and all participants signed an informed consent before recruitment.

Individual information and response rates

Study subjects were interviewed face-to-face by trained study personnel. Interviews were conducted in the hospitals (cases and hospital-based controls) and in primary health care facilities or nearby research centers (population-based controls). Questionnaires used are available online (http://mccspain.org). Data collected included sociodemographic characteristics; residential history from age 18 years to recruitment; water type consumed in each residence (municipal/bottled/well/other); amount of daily water intake (including water per-se, coffee, tea and other water-based beverages); smoking habits; history of gastric ulcer, diabetes, inflammatory bowel disease or Crohn's disease, use of non steroidal anti-inflammatory drugs (NSAIDs); oral contraceptive (OC) use, and hormonal replacement therapy (HRT); leisure physical activity since age 16 (Spain) or 15 years (Italy); family history of CRC, and information on the quality of the interview. Long-term exposure levels to trihalomethanes (THMs) in drinking water were available for the study population. Dietary information, corresponding to 2 years before recruitment, was collected using validated food frequency questionnaires (FFQs).[21,22] The FFQs included 140 (Spain) or 78 (Italy) food-items, and were administered during the interview in Italy (as part of the main questionnaire) or self-administered in Spain. Average response rates among cases were 58% in Spain (ranging from 33% to 80% among areas) and 95% in Italy, and among controls were 52% Spain (ranging from 30% to 68% among areas) and 95% in Italy. Average response rate for the FFQ in Spain was 88%. In total, 2,371 cases (1,905 Spain, 466 Italy) and 4,159 controls (3,590 Spain, 569 Italy) were interviewed.

Nitrate levels in municipal drinking water

We collected data for the municipalities covering 80% of total person-years in each area. We sent a standardized questionnaire to local authorities and water companies to ascertain current and historical nitrate measurements at the distribution system, and water source characteristics (surface/groundwater proportion). Monitoring levels for 2004–2010 were provided in Spain by the SINAC (*Sistema de Información Nacional de Aguas de Consumo*), and by the Regional Environmental Health Agency (Milan) and the Local Health Authority (Pordenone/Udine) in Italy. Measurements below the quantification limits (QL) (5% of measurements) were imputed half the QL value. If the QL value was missing, the measurement was imputed half of the most frequent QL reported (1.0 mg/L). More details on environmental data available are presented in Supporting Information (Table 1).

Nitrate levels in non-municipal drinking water

Data from the most consumed bottled water brands were available from previous reports in Spain[23] and Italy.[24] Nitrate levels in wells and springs outside the municipal water distribution system were measured in September 2013 in the area of León (Spain), where non-municipal well water consumption was the highest among the study areas (28% of controls in the longest residence). A total of 28 water samples were collected in 21 municipalities. The proportion of well water consumption in other areas ranged from 0.3% to 24% in the longest residence (33 years long, on average). These were considered as missing values given the lack of well water data in those areas.

Estimation of long-term nitrate levels in drinking water

We explored heterogeneity of nitrate levels within each municipality, by comparing the levels available for different sampling points, to identify water zones, defined as geographical areas supplied from a homogeneous water source and with similar nitrate levels. Most of the municipalities comprised only one water zone, and some of the municipalities (*e.g.*, Barcelona and Milan) had water zones already defined with different water sources. Long-term nitrate levels were estimated for 349 water zones, in total (Supporting Information Table 1). We calculated annual average by water zone using available measurements. For years without measurements, we back extrapolated the average of total measurements in the water zone back to 1940, as long as water source remained constant. Nitrate levels in ground water sources are usually higher than in surface sources.[25] Therefore, we used ground water percentage as a weight to calculate nitrate estimates when water source changed, assuming that levels increased proportionally to the percentage of ground water supplied. This assumption was evaluated for each water zone, and was applied uniformly in all municipalities where data was not sufficient to conduct this evaluation. In municipalities without nitrate measurements (covering 0.5% of the total person-years), we assigned the levels of neighboring municipalities supplied with similar surface/ground water proportion ±10%. We defined a reliability score for each annual nitrate estimate, ranging from 0 (lowest reliability) to 2 (highest), that penalized estimates that were imputed, calculated based on few number of measurements, and more distant in time to an actual measurement. We used this score for sensitivity analyses.

Estimation of waterborne nitrate exposure

We linked nitrate levels with residential histories by year and municipality (or water zone) covering an exposure period from age 18 to 2 years before the interview ("adult life"), among cases and controls. Since more nitrate measurements were available in recent decades, our "main exposure period" covered from 30 to 2 years before the interview. We also evaluated an exposure period from age 18 to 30 years ("early adult life"). We calculated average residential levels (mg/L as NO_3^-) and average waterborne ingested nitrate (mg/day) for each exposure period.

We calculated waterborne ingested nitrate according to amount and type of water consumed. We assigned residential levels when subjects reported tap water consumption. Published levels in bottled water brands were averaged using the sales frequency of each brand as a weight and were assigned when bottled water consumption was reported (6.1 mg/L in Spain and 3.8 mg/L in Italy). Levels from well water samples in León (range 0.5–93 mg/L) were assigned to well water consumers in this area, according to the postal code of wells' location. The annually assigned levels were averaged and multiplied by the daily water intake (mean $\pm$ SD $=$ 1.4 ± 0.8 L/day in cases and 1.3 ± 0.9 L/day in controls). Water intakes above the 99th percentile (4 L/day), considered non plausible, were treated as missing values in the analyses.

To address the potential misclassification of the water type consumed (municipal/bottled) in recent residences, we calculated an alternative variable of waterborne ingested nitrate. We assumed that subjects reporting bottled water consumption and living during at least 10 years in the current (or previous) residence, consumed municipal water before the year 2000 and bottled water thereafter. This was assumed based on results from a subgroup with information on water type changes within residences ($n = 174$), showing that among 86% of subjects reporting bottled water consumption in the current residence, actually switched from municipal to bottled water after the year 2000. Similar calculations were done for Italy, using the cutoff at 1980 according to Italian data.

Estimation of dietary nutrients and nitrate

Data collected through FFQs were used to estimate the average daily intake of food groups and nutrients (vitamins C, E, and energy). Nutrients' contents were calculated using published food composition databases.[26,27] Dietary nitrate intake (mg/day) was estimated based on average intake of food items (g/day) and published nitrate content (mg/100 g) in food items including vegetables,[4] animal products and others.[28,29] Nitrate contents (mg/100 g) were calculated for 21 vegetables (including tubers), 13 fruits, 17 foods from animal sources (including red, white, processed meat and dairy products), 3 frequently consumed foodstuff (bread, rice and pasta) and 1 alcoholic beverage (beer). For these calculations "red meat" included: beef, lamb and pork meat. "Processed meat" included: bacon, hot dogs, smoked ham, Spanish cured ham and other cured sausages.

Statistical analyses

Subjects with nitrate exposure covering less than 70% of the last 30 years before the interview, and with unsatisfactory quality interview ($n = 24$) were excluded, leading to 1,869 cases and 3,530 controls analyzed. Nitrate exposure variables were categorized attempting to have subjects from different areas in all categories and high numbers in the reference. Odds ratios (OR) and 95% confidence intervals (CI) of CRC were calculated using mixed models with "area" as random effect. Basic models were adjusted for sex, age, study area and education. Potential confounders were explored overall and separately for men and women, including: smoking (never/ever), physical activity (measured in METs Metabolic equivalents of task/hour/week), body mass index (BMI), history of CRC in first degree relatives, NSAIDs use, OC use and HRT (in women), intake of energy, fiber, alcohol and endogenous nitrosation modulators (intake of vitamin C, vitamin E, red meat, processed meat and gastric ulcer history). Only variables that changed the risk estimates $\geq$10% were retained in the adjusted models.[11] In alternative analyses, models were adjusted for THM levels (residential and waterborne ingested) in the main exposure period. Missing values in categorical covariables were coded as another category. We evaluated the exposure-response relationship between waterborne nitrate exposure and CRC risk using generalized additive models (GAMs).

We stratified analyses of waterborne ingested nitrate by sex, cancer site, endogenous nitrosation modulators and other potential effect modifiers. Strata of quantitative variables ($\leq$ or $>$ median) were defined according to the distribution in controls. We compared the models with and without the interaction term using the likelihood ratio test, and p values less than 0.10 were considered indicative of multiplicative interaction. Stratified analyses by endogenous nitrosation factors were also conducted for men and women separately. We conducted several sensitivity analyses including the use of alternative variables of waterborne ingested nitrate in different exposure windows, and excluding exposure estimates (residential levels) with low reliability score (score value <0.50 $N = 1{,}077$). STATA version 12.0 (Stata Corp, College Station, TX) was used for all statistical analyses.

Results

Characteristics of the population analyzed are shown in Table 1. Family history of CRC, high BMI, high intake of energy, alcohol, red meat and processed meat were more frequent among cases (Chi^2 p values <0.05). The amount of water intake was also higher among cases (t test p values <0.05). Compared with the excluded, the subjects analyzed showed a higher proportion of controls, were younger, with lower physical activity, more frequent use of NSAIDs, and had lower ($\leq$5 mg/L) or higher ($\geq$10 mg/L) residential nitrate levels (Supporting Information Table 2).

On average (mean $\pm$ SD), this population had 3.3 ± 1.6 residences in adult life, and the time living in the most recent residence was 29.3 ± 14.9 years. The number of years (mean $\pm$ SD) with nitrate measurements available ranged from 4.0 ± 1.7 to 13.4 ± 1.5, among study areas. Nitrate measurements were available for 19% of the main exposure

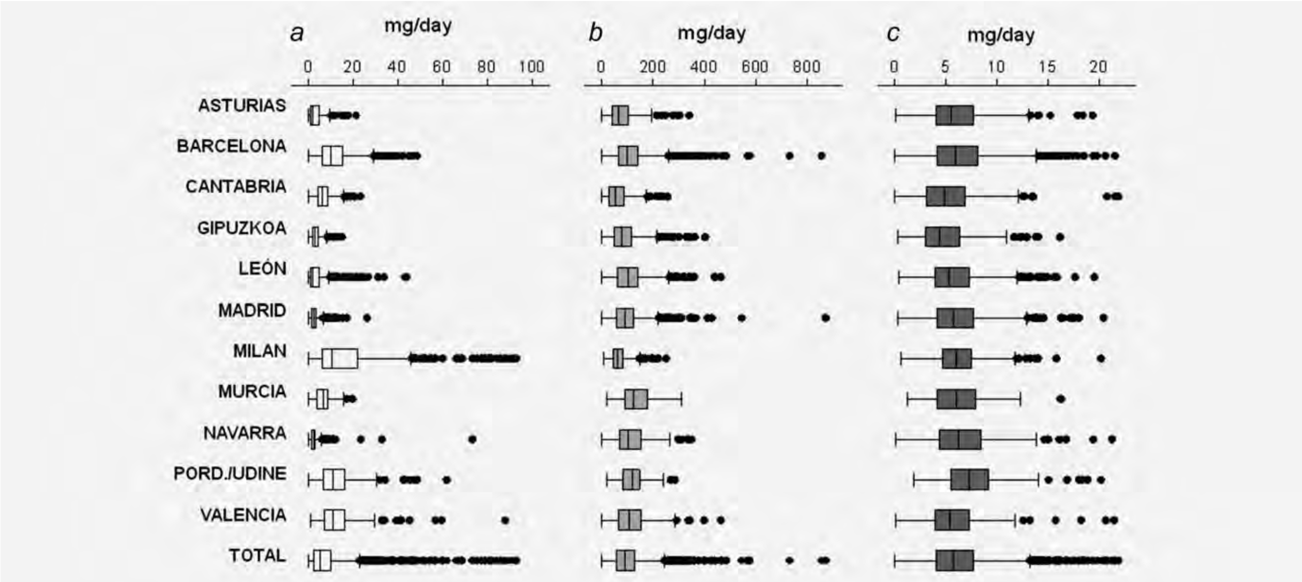

Figure 1. Average nitrate exposure levels among study areas. (*A*) Waterborne intake in the main exposure period (excluding intakes >105.8 mg/day, $n = 5$). (*B*) Dietary intake from vegetable sources (excluding intakes >1,000 mg/day, $n = 2$). (*C*) Dietary intake from animal sources (excluding intakes >22 mg/day, $n = 16$).

period (from 30 to 2 years before the interview), on average. Municipal water consumption was longer than bottled or well water consumption (19.2 ± 12.6 *vs.* 10.5 ± 16.5, and 0.8 ± 4.2 years, respectively), with differences among regions (Supporting Information Table 1).

Figure 1 shows average nitrate exposure levels through drinking water and diet during the main exposure period (from 30 to 2 years before the interview). Waterborne ingestion (mean ± SD) ranged from 3.4 ± 3.3 to 19.7 ± 22.6 mg/day, and residential levels ranged from 1.6 ± 0.9 to 30.0 ± 4.4 mg/L, among areas. The levels were similar in other exposure periods (results not shown). A high correlation was found between waterborne nitrate ingestion during the main exposure period and alternative exposure periods (*Spearman* correlation coefficients $r = 0.98$ with levels in adult life, and 0.91 with levels in early adult life). Dietary nitrate intake (mean ± SD) was 118 ± 72 mg/day (102 ± 70.5 mg/day from vegetables and 6.2 ± 3.3 mg/day from animal sources).

Table 2 shows the risk of CRC associated with waterborne ingested nitrate, overall and stratified by sex, for colon and rectum cancers sites. Adjusted ORs (95%CIs) of CRC for >10 versus ≤5 mg/day were 1.49 (1.24–1.78) overall, 1.50 (1.21–1.87) among men and 1.41 (1.04–1.91) among women. Interaction by sex was statistically significant for colorectal and colon, but not for rectal cancer. Results differed moderately by cancer site. The analyses of the alternative exposure periods led similar results, as well as the sensitivity analyses excluding subjects with low reliable score, or the subjects with less reliable interviews. Stratified analyses by time living in the current residence (≤15 years, >15–30 years and >30 years) also led similar results (not shown in tables). The ORs decreased slightly with additional adjustment for chloroform levels, while slightly increased after adjustment for brominated THMs (see Supporting Information Table 3).

Average residential nitrate levels were also associated with increased CRC (see Supporting Information Table 4), although the ORs were higher than those observed with waterborne ingested nitrate. These variables were moderately correlated, overall (*Spearman* correlation coefficient $r = 0.66$), but with wide differences among areas (*e.g.*, −0.04 in Madrid to 0.39 in León). In sensitivity analyses, areas with more than 10% of cases (Barcelona, León and Madrid) and Italian areas were alternatively excluded from the models. The ORs (95%CI) for the highest exposure category (>10 *vs.* <5 mg/L) decreased mostly after excluding Barcelona and Italian areas, but remained statistically significant. The ORs were higher among men versus women (interaction p values <0.001), and slightly higher for colon versus rectum tumors.

Figure 2 shows the GAMs for waterborne ingested nitrate. A small increase in CRC risk was found at ingested levels between 10 and 30 mg/day, among men and overall. At higher levels, the exposure-response curve was flat, with wide CIs. Area-specific GAMs showed heterogeneous exposure-response curves between areas (Supporting Information Fig. 1).

Table 3 shows stratified analyses by dietary endogenous nitrosation factors and fiber intake, overall and by cancer site. High ORs (95%CI) were found in the groups with highest waterborne ingested nitrate and highest red meat intake, particularly among men: 1.71 (1.30, 2.26) (see results by sex in Supporting Information Table 5). Results for processed meat were similar to results for red meat, overall (not shown in tables). Inverse ORs (95%CI) of CRC were found among the groups with low ingested nitrate and high vitamin E

Table 2. Colorectal cancer risk associated with waterborne nitrate ingestion during the main exposure period in all population ($n = 5,399$) and stratified by cancer site and sex

Mean nitrate ingestion	≤5 mg/day			>5–10 mg/day			>10 mg/day		
	Cases	Contr.	OR[1] (95%CI)	Cases	Contr.	OR[1] (95%CI)	Cases	Contr.	OR[1] (95%CI)
Cancer site Colorectal[2]									
All	778	1,899	1.00 (ref.)	447	803	1.17 (0.98, 1.38)	644	828	1.49 (1.24, 1.78)
Men	498	918	1.00 (ref.)	289	454	1.16 (0.94, 1.44)	397	468	1.50 (1.21, 1.87)
Women	280	981	1.00 (ref.)	158	349	1.20 (0.90, 1.58)	247	360	1.41 (1.04, 1.91)
Colon[2]									
All	527	1,899	1.00 (ref.)	324	803	1.28 (1.06, 1.55)	434	828	1.52 (1.24, 1.86)
Men	322	918	1.00 (ref.)	202	454	1.26 (0.99, 1.61)	260	468	1.51 (1.17, 1.94)
Women	205	981	1.00 (ref.)	122	349	1.33 (0.97, 1.80)	174	360	1.46 (1.04, 2.05)
Rectum[2]									
All	244	1,899	1.00 (ref.)	110	803	0.93 (0.70, 1.23)	203	828	1.62 (1.23, 2.14)
Men	169	918	1.00 (ref.)	80	454	0.94 (0.68, 1.28)	133	468	1.55 (1.16, 2.08)
Women	75	981	1.00 (ref.)	30	349	0.87 (0.52, 1.45)	70	360	1.49 (0.89, 2.48)

[1]Odds ratios (OR) and 95% confidence intervals (CI). Results of mixed models with "area" as random effect, adjusted for: sex, age, education, body mass index, physical activity, non-steroidal anti-inflammatories use, family history of colorectal cancer and intake of energy. Analyses for women were also adjusted for oral contraceptives use.
[2]Interaction *p values* by sex = *0.01* for colorectal, *0.05* for colon and *0.15* for rectal cancer.

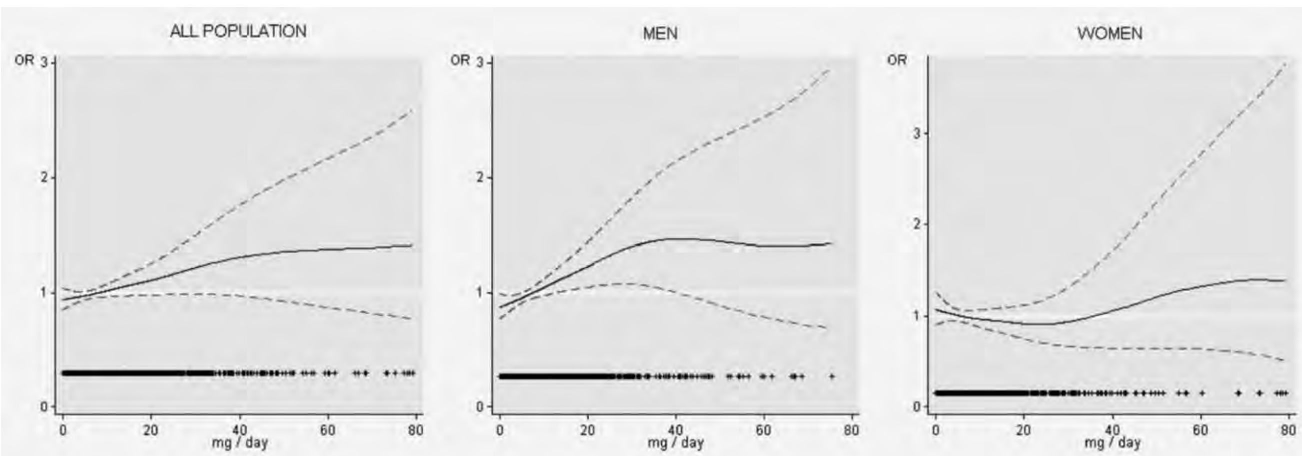

Figure 2. Exposure-response relationship between average waterborne ingested nitrate (mg/day) during the main exposure period and colorectal cancer risk. Generalized additive models (GAMs) adjusted for study area, sex, age, education, physical activity, body mass index, use of non-steroidal anti-inflammatory drugs, family history of colorectal cancer and energy intake. Subjects with ingestion levels >80 mg/day ($n = 21$) were excluded from these analyses.

(0.73, 0.59–0.89), and high fiber intake (0.65, 0.53–0.80). Results by cancer site showed similar results for colon cancer, but inverse ORs with vitamin C and fiber were found for rectum cancer. Stratified results did not differ by diabetes diagnosis, or smoking (not shown).

Table 4 shows the risk of CRC (overall and by cancer site) associated with dietary ingested nitrate. An association (OR, 95%CI) with nitrate intake from animal sources was found for rectal cancer (1.55, 1.17–2.05) while no association was observed for colon cancer (1.06, 0.87–1.30). Ingestion from total diet or vegetables led to null or inverse associations with CIs around the null value for both cancer sites. Waterborne and dietary ingested nitrate were poorly correlated (*Spearman* correlation coefficient for nitrate from total diet: 0.07, vegetables: 0.06 and animal sources: 0.07). The adjustment of waterborne ingested nitrate analyses' for dietary nitrate intake (through different sources) did not change the main results (results not shown).

Discussion

Results of this large case–control study suggest a positive association between CRC risk and long-term exposure to nitrate in drinking water, at levels below 50 mg/L of NO_3^-, particularly in subgroups of the population, such as men and

Table 3. Colorectal cancer risk associated with waterborne ingested nitrate levels in the main exposure period. Joint effect with endogenous nitrosation factors and other dietary covariables in all population and by cancer site

Covariable Intake	Nitrate intake mg/day	Colorectal cancer ($n = 4{,}858$[1])		Colon cancer ($n = 4{,}326$[1])		Rectal cancer ($n = 3{,}680$[1])		
		Cases	OR[2] (95%CI)	Cases	OR[2] (95%CI)	Cases	OR[2] (95%CI)	Controls
Red meat								
≤29 g/day	≤4.4	296	1.00 (ref.)	209	1.00 (ref.)	85	1.00 (ref.)	842
	>4.4	380	1.09 (0.88–1.35)	265	1.12 (0.88, 1.44)	107	1.08 (0.76, 1.55)	744
>29 g/day	≤4.4	349	1.24 (1.02–1.51)	221	1.17 (0.93, 1.47)	124	1.49 (1.09, 2.02)	742
	>4.4	660	1.56 (1.26–1.94)	458	1.66 (1.30, 2.12)	191	1.57 (1.11, 2.21)	845
Interaction p values			0.27		0.12		0.90	
Vitamin C								
≤137 mg/day	≤4.4	343	1.00 (ref.)	218	1.00 (ref.)	121	1.00 (ref.)	766
	>4.4	589	1.20 (0.98–1.47)	409	1.36 (1.08, 1.71)	168	0.99 (0.73, 1.36)	820
>137 mg/day	≤4.4	302	0.83 (0.68–1.01)	212	0.92 (0.73, 1.15)	88	0.67 (0.49, 0.91)	818
	>4.4	451	0.95 (0.77–1.18)	314	1.09 (0.86, 1.38)	130	0.77 (0.56, 1.07)	769
Interaction p values			0.73		0.35		0.45	
Vitamin E								
≤10 mg/day	≤4.4	355	1.00 (ref.)	238	1.00 (ref.)	112	1.00 (ref.)	806
	>4.4	531	1.15 (0.94, 1.42)	373	1.26 (1.00, 1.59)	149	1.03 (0.75, 1.43)	780
>10 mg/day	≤4.4	290	0.73 (0.59, 0.89)	192	0.73 (0.57, 0.93)	97	0.75 (0.54, 1.04)	778
	>4.4	509	0.87 (0.70, 1.09)	350	0.94 (0.73, 1.21)	149	0.81 (0.57, 1.15)	809
Interaction p values			0.74		0.89		0.85	
Fiber								
≤20 g/day	≤4.4	344	1.00 (ref.)	224	1.00 (ref.)	115	1.00 (ref.)	741
	>4.4	595	1.13 (0.92–1.38)	422	1.28 (1.01, 1.61)	159	0.90 (0.66, 1.24)	845
>20 g/day	≤4.4	301	0.65 (0.53–0.80)	206	0.71 (0.56, 0.89)	94	0.55 (0.40, 0.76)	843
	>4.4	445	0.84 (0.68–1.04)	301	0.92 (0.73, 1.18)	139	0.72 (0.52, 1.00)	744
Interaction p values			0.32		0.88		0.07	

[1]Numbers do not add 5,399 due to missing values in dietary variables and cancer site.
[2]Odds ratios (OR) and 95% confidence intervals (CI). Results of mixed models with "area" as random effect adjusted for: sex, age, education, physical activity, non-steroidal anti-inflammatory drugs use, family history of colorectal cancer and energy intake.

Table 4. Dietary ingested nitrate and colorectal cancer risk stratified by cancer site among population with available dietary information ($n = 4{,}858$)

Ingested nitrate from:	Median intake (mg/day)	Colorectal cancer		Colon cancer		Rectal cancer		Controls
		Cases[1]	OR[2] (95% CI)	Cases	OR[2] (95% CI)	Cases	OR[2] (95% CI)	
Animal sources								
<4.5 mg/day	3.1	473	1.00 (ref.)	352	1.00 (ref.)	112	1.00 (ref.)	1,058
4.5–6.8 mg/day	5.6	578	1.15 (0.98, 1.35)	378	1.03 (0.86, 1.24)	191	1.59 (1.22, 2.06)	1,058
>6.8 mg/day	9.4	634	1.16 (0.98, 1.38)	423	1.06 (0.87, 1.30)	204	1.55 (1.17, 2.05)	1,057
Continuous			1.03 (1.01, 1.05)		1.02 (1.00, 1.04)		1.04 (1.01, 1.07)	
Vegetable sources[3]								
<68 mg/day	42	597	1.00 (ref.)	392	1.00 (ref.)	194	1.00 (ref.)	1,058
68–118 mg/day	92	575	0.99 (0.85, 1.16)	397	1.04 (0.87, 1.24)	169	0.91 (0.71, 1.16)	1,058
>118 mg/day	179	513	0.83 (0.70, 0.99)	364	0.89 (0.73, 1.08)	144	0.75 (0.57, 0.99)	1,057
Continuous			1.00 (0.99, 1.00)		1.00 (0.99, 1.00)		1.00 (0.99, 1.00)	
Total diet[3]								
<83 mg/day	59	594	1.00 (ref.)	388	1.00 (ref.)	195	1.00 (ref.)	1,058
83–133 mg/day	108	564	0.97 (0.83, 1.14)	394	1.04 (0.87, 1.24)	161	0.85 (0.66, 1.08)	1,058
>133 mg/day	176	527	0.84 (0.70, 1.00)	371	0.90 (0.74, 1.10)	151	0.76 (0.58, 1.00)	1,057
Continuous			1.00 (0.99, 1.00)		1.00 (0.99, 1.00)		1.00 (0.99, 1.00)	

[1]This column does not add to total number of cancer cases since 46 were undefined site.
[2]Odds ratios (OR) and 95% confidence intervals (CI). Results of mixed models with "area" as random effect adjusted for sex, age, education, physical activity, non-steroidal anti-inflammatory drugs use, family history of colorectal cancer, body mass index and intake energy.
[3]Results are also adjusted for fiber intake.

subjects with high red meat intake. The associations slightly differed for colon and rectal cancer. A positive association was found between rectal cancer risk and nitrate intake from animal sources, but an inverse association is suggested with intake from vegetables.

This is one of the few studies evaluating CRC risk and nitrate exposure through drinking water. Our results are comparable to previous case–control studies from the United States, although those studies evaluated residential, but not ingested nitrate, at higher levels than those observed in our study. A 2.9-fold increased risk of proximal colon cancer for NO_3-N residential levels $\geq$10 mg/L (44 mg/L of NO_3^-) versus <0.5 mg/L has been reported.[30] Increased risk of colon cancer was found among subjects with residential NO_3-N levels >5 mg/L for >10 years and low vitamin C intake or high meat intake.[16] Other available studies had ecologic design or ignored endogenous nitrosation factors and individual water consumption data,[31,32] thus are not totally comparable to our study.

Dietary ingested nitrate levels in this study were similar to those observed in other western countries.[33] Our results are consistent with a cohort study[15] that found higher colon cancer risk with ingested nitrate from animal sources. Results from other studies on CRC and dietary nitrate, nitrite or NOCs are heterogeneous,[5,6,13,14] and most of them did not evaluate ingestion from different dietary sources. In contrast to results for animal-derived nitrate, inverse associations were found for high nitrate intake from vegetables. These results may not be confounded by the protective effect of fiber, since the analyses were adjusted for this variable. The presence of endogenous nitrosation inhibitors in vegetables and hypothesized beneficial effects of nitrate from vegetables[34] may partly explain these findings.

Our results suggest an interaction between waterborne nitrate exposure and sex for CRC and colon cancer, but not for rectal cancer. The associations were higher among men, similarly to other exposures such as dietary factors.[35] This may partly be attributed to the protective effect of estrogens and other hormonal factors.[36] We found higher associations in groups with high red meat intake. These results were consistent with previous studies that evaluated other cancer types associated with nitrate or nitrite exposure.[33,37] Although the interaction with red meat was not statistically significant, is plausible, because red meat contains amines, amides, and heme iron which may increase endogenous formation of NOCs.[38] Information on heme iron intake was not available in this study, but should be accounted to evaluate the interaction with red meat in future analysis.[39] In contrast, inverse associations were found in groups of high vitamin E or fiber intake. Vitamins E and C inhibit endogenous nitrosation, and a protective effect is biologically plausible. The combined intake of vitamins C and E showed similar effects to those shown for each vitamin. The protective effect of fiber was also expected, based on previous evidence on fiber intake and CRC risk.[40] Apart from endogenous nitrosation, changes in gastrointestinal microbiota,[41] and genetic variants of CYP2E1 (involved in NOCs' bio-activation),[14] may also play a role in carcinogenesis of ingested nitrate and should be explored in future analyses.

Confounding by other water contaminants such as THMs[42] was a concern. In this study, estimates of THMs intake were available, and were evaluated as potential confounders. Associations decreased slightly after adjusting for chloroform, and increased slightly after adjusting for brominated THMs or total THMs, but the differences were not statistically significant. The potential interaction of these frequent water contaminants requires further evaluation, since contradictory effects are suggested for chlorinated versus brominated THMs. Other water contaminants showed levels around or below the QL in our study areas,[23] and are not likely to be relevant confounders in the context of this study.

Although different response rates between study areas and relatively low rates among controls may be a limitation, nonparticipation is unlikely related to nitrate exposure. Potential exposure measurement error is a limitation, since nitrate measurements in drinking water were only available in recent years. Missing historical levels were estimated based on recent measurements and were assumed to remain stable over time, depending on groundwater percentages. This assumption may introduce measurement error, particularly for long-term periods (*e.g.*, adult life). Nitrate levels may differ widely between groundwater sources according to the depth of wells, and may change in time according to factors other than water source (*e.g.*, agricultural practices). Such information was not collected, since the questionnaire was not originally designed to estimate historical nitrate levels, and was not available in official reports. However, we analyzed the municipalities with longest nitrate records: Llíria (Valencia) and Donostia (Gipuzkoa), and no significant changes were found in nitrate levels over 17 years. The levels estimated for a 30-year period would be sufficient to evaluate the association with CRC risk, among this population. Additionally, we applied several strategies to address the potential exposure measurement error: we analyzed only the population with exposure information available for $\geq$70% of the main exposure period (30 to 2 years before the interview). We performed sensitivity analyses excluding less reliable exposure estimates, obtaining similar results to those shown in Table 2. We analyzed three different exposure periods, but results for adult life and early adult life are limited because are based on estimates with low reliability. In addition, nitrate estimates from different exposure periods were highly correlated. Studies in other settings, with larger availability of historical environmental data, are needed to increase the current evidence on waterborne nitrate exposure and CRC risk.

Since dietary information was collected with a FFQ, recall bias may not be totally ruled out in the analyses for dietary nitrate. The results for dietary nitrate intake may not be extrapolated for long-term periods, since dietary information corresponded to the last 2 years previous to recruitment. Estimates of dietary nitrate are prone to measurement error since we used the same nitrate contents in food products, regardless of potential country-specific levels. However, the database used is valid for all European countries, and includes specific Spanish and Italian measurements.[4] Data on relevant vegetable sources of nitrate was not completely available, and data on storage and processing (*i.e.*, washing, peeling and cooking) was not collected, which also may introduce error in calculations of nitrate intake from vegetables. Finally, dietary nitrite intake was not available, but this would not be a major limitation since the main exposure route expected is through endogenous nitrate reduction.[8]

The wide differences on nitrate levels between study areas, and the low variability within areas hampered the statistical analyses. We applied different approaches for all-area combined analyses, including unconditional logistic regression, GAMs, and meta-smoothing analyses[43] (previously used in multicentric studies on air pollution). Mixed models, with area as random effect were finally applied given the heterogeneity of results between study areas. This heterogeneity is a limitation, and is probably related to other environmental or individual factors that were not evaluated in this study. The results of mixed models differed slightly from results of the GAMs, particularly among women. Results among women may be less robust due to the smaller sample size, compared with men. Results of meta-smoothing analyses are not shown, because were equivalent to results of the GAMs.

A main strength of this study was the availability of detailed individual information, allowing the assessment of several potential confounders and effect modifiers, including other frequent water contaminants (THMs) and endogenous nitrosation factors. In addition, the FFQ information enabled us to assess nitrate exposure through different dietary sources. Nitrate measurements in non municipal water (wells) were measured and included in the exposure assessment for the area with the highest consumption of this water type (León). Finally, the main results were robust, as were replicated using different approaches for statistical analysis.

Conclusions

Overall, effects of nitrate exposure differed by exposure source (water, vegetables and animal dietary sources). A positive association is suggested between CRC risk and long-term exposure to nitrate in drinking water at levels below the European regulatory limit, particularly among subjects with other risk factors. Dietary nitrate from animal sources increased rectal cancer risk, but high intake from vegetables seems to decrease it. Further research is required to confirm these findings.

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Nitrate in drinking water and colorectal cancer risk: A nationwide population-based cohort study

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Nitrate in drinking water may increase risk of colorectal cancer due to endogenous transformation into carcinogenic *N*-nitroso compounds. Epidemiological studies are few and often challenged by their limited ability of estimating long-term exposure on a detailed individual level. We exploited population-based health register data, linked in time and space with longitudinal drinking water quality data, on an individual level to study the association between long-term drinking water nitrate exposure and colorectal cancer (CRC) risk. Individual nitrate exposure was calculated for 2.7 million adults based on drinking water quality analyses at public waterworks and private wells between 1978 and 2011. For the main analyses, 1.7 million individuals with highest exposure assessment quality were included. Follow-up started at age 35. We identified 5,944 incident CRC cases during 23 million person-years at risk. We used Cox proportional hazards models to estimate hazard ratios (HRs) of nitrate exposure on the risk of CRC, colon and rectal cancer. Persons exposed to the highest level of drinking water nitrate had an HR of 1.16 (95% CI: 1.08–1.25) for CRC compared with persons exposed to the lowest level. We found statistically significant increased risks at drinking water levels above 3.87 mg/L, well below the current drinking water standard of 50 mg/L. Our results add to the existing evidence suggesting increased CRC risk at drinking water nitrate concentrations below the current drinking water standard. A discussion on the adequacy of the drinking water standard in regards to chronic effects is warranted.

Nitrate is leached to the aquatic environment, originating mainly from human activities, especially the use of fertilizers in intensive agriculture, and is a frequent drinking water pollutant.[1–3] Denmark is among the countries with the most intensive agriculture with two-thirds of its area under cultivation, resulting in pronounced nitrate pollution of groundwater.[4] The Danish drinking water structure is decentralized and based exclusively on groundwater.[5] The drinking water standard of 50 mg/L as nitrate ion was established to protect infants from the acute condition methemoglobinemia.[1] This standard is almost equivalent to the United States Environmental Protection Agency's maximum contaminant level of 10 mg/L as nitrogen.

Key words: nitrate, drinking water, colorectal cancer, Denmark, cohort studies
Abbreviations: CRC: colorectal cancer; CI: confidence interval; HR: hazard ratio
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However, physiological pathways of possible chronic effects have been suggested, due to endogenous transformation of nitrate into genotoxic *N*-nitroso compounds.[6] Most *N*-nitroso compounds are animal carcinogens,[7] and nitrate has been classified as probably carcinogenic to humans under conditions that favor endogenous nitrosation.[8] Colorectal cancer (CRC) is the third most frequent cancer worldwide,[9] with an age-standardized incidence rate of 43.6 (males) and 33.8 (females) per 100,000 persons per year in Denmark.[10]

Previous epidemiological studies on the association between nitrate in drinking water and CRC are few and yielded inconsistent results.[6] An ecologic study in Slovakia found a positive association between nitrate levels in drinking water and cancers in all digestive organs and CRC in particular.[11] A case–control study in Iowa showed an increased colon cancer risk at elevated nitrate levels in drinking water among susceptible subgroups with elevated endogenous nitrosation, that is, low vitamin C and high red meat intake.[12] A prospective cohort study of women carried out in the same area with a similar exposure assessment found no significant association between colon cancer and the quartile exposed to

What's new?
Nitrate is considered a probable carcinogen in humans owing to its potential for endogenous transformation into genotoxic *N*-nitroso compounds. Cancer risk related to nitrate pollution in drinking water, as a consequence of intensive agriculture using fertilizers, is of particular concern. Here, analyses of water quality data and health registry data with a high spatiotemporal resolution for 2.7 million people in Denmark reveal an increased risk of colorectal cancer (CRC) in association with nitrate exposure. CRC risk was elevated at nitrate concentrations below the current drinking water standard.

the highest concentrations, while the second and third quartiles showed increased risks, and an inverse association was observed for rectal cancer.[13] A case–control study of women in Wisconsin found no overall association with colon or rectal cancer, but an increased risk of proximal colon cancer at nitrate levels around the drinking water standard.[14] A recent case–control study from Spain and Italy showed the higher the intake of nitrate from drinking water, the higher the risk of colon and rectal cancer, also at levels well below the drinking water standard.[15]

A common limitation of previous studies is the limited ability to access historical nitrate exposure for study subjects. To identify potentially small chronic effects, long-term follow-up of a large population is necessary. Large studies with well-characterized long-term exposures and inclusion of private well users were called for[6] assessing populations with large exposure contrast, even if concentrations are below the drinking water standard.[16]

We addressed these limitations by using the rich population-based Danish registers including longitudinal health and residential information,[17] linked in time and space with the likewise longitudinal information on drinking water quality with high spatial and temporal resolution, covering the entire country from 1978 onward.[5,18] The link of these unique nationwide and longitudinal data sources enabled us to study the association between nitrate in drinking water and CRC on an individual level.

Methods

We followed all Danish residents for development of CRC considering nitrate in drinking water as the exposure of interest. Details are described in the following sections.

Study design and population

The unique personal identification number, which is assigned to all Danish residents, was used as key identifier to accurately link data from several registers. Prospectively collected and continuously updated information on date of birth, sex, residential history and vital status were retrieved from the Danish Civil Registration System.[17] The study period was January 1, 1978 to December 31, 2011, as residential history was geocoded for this period. We defined the cohort as all residents of Denmark, alive on their 35th birthday. We followed each individual from their 35th birthday until the onset of colon or rectal cancer, the end of study (31 December 2011), death, emigration or disappearance. Diagnoses of colon cancer (ICD-10 codes C18 and C19), rectal cancer (C20) and all other cancers were retrieved from the Danish Cancer Registry, which has a high validity and degree of completeness.[19]

Exposure assessment

The approach of assigning each household to its annual nitrate concentration is described in detail elsewhere.[18] In brief, we assigned annual average drinking water nitrate concentrations, registered at waterworks level, to the 2,852 public water supply areas and the 2,382,445 publicly supplied households within these. Privately supplied households (81,663) were identified and assigned nitrate concentrations of their private well. In total, 208,706 drinking water samples with precise sampling date and location were used in this study. We interpolated concentrations for years without available nitrate measurements at household level. An exposure assessment quality level based on the number of years to the closest nitrate sample was calculated for each household and year (for detailed explanation of the levels, see results from sensitivity analyses in Table 2).

We calculated each individual's average nitrate exposure between their 20th and 35th birthday by linking their residential history from 1978 onward in time and space to the longitudinal drinking water nitrate concentration data at the Danish households. To be able to calculate an individual's exposure, their exposure window had to overlap with the study period, that is, their 35th birthday had to be after the beginning of study (January 1, 1978) and before the end of study (December 31, 2011). For the main analyses, we included only individuals with a high exposure assessment quality, having lived at least 75% of the time at households with an associated nitrate sample taken within 1 year.

Covariates

Covariates were selected *a priori*. Socioeconomic status was based on the *highest attained education* of each individual from the educational registers and included in four categories: (*i*) primary school only, (*ii*) shorter education (high school and short vocational training), (*iii*) medium long education (vocational training and bachelors) and (*iv*) long education (academics).[20] We included information on any *previous cancer*

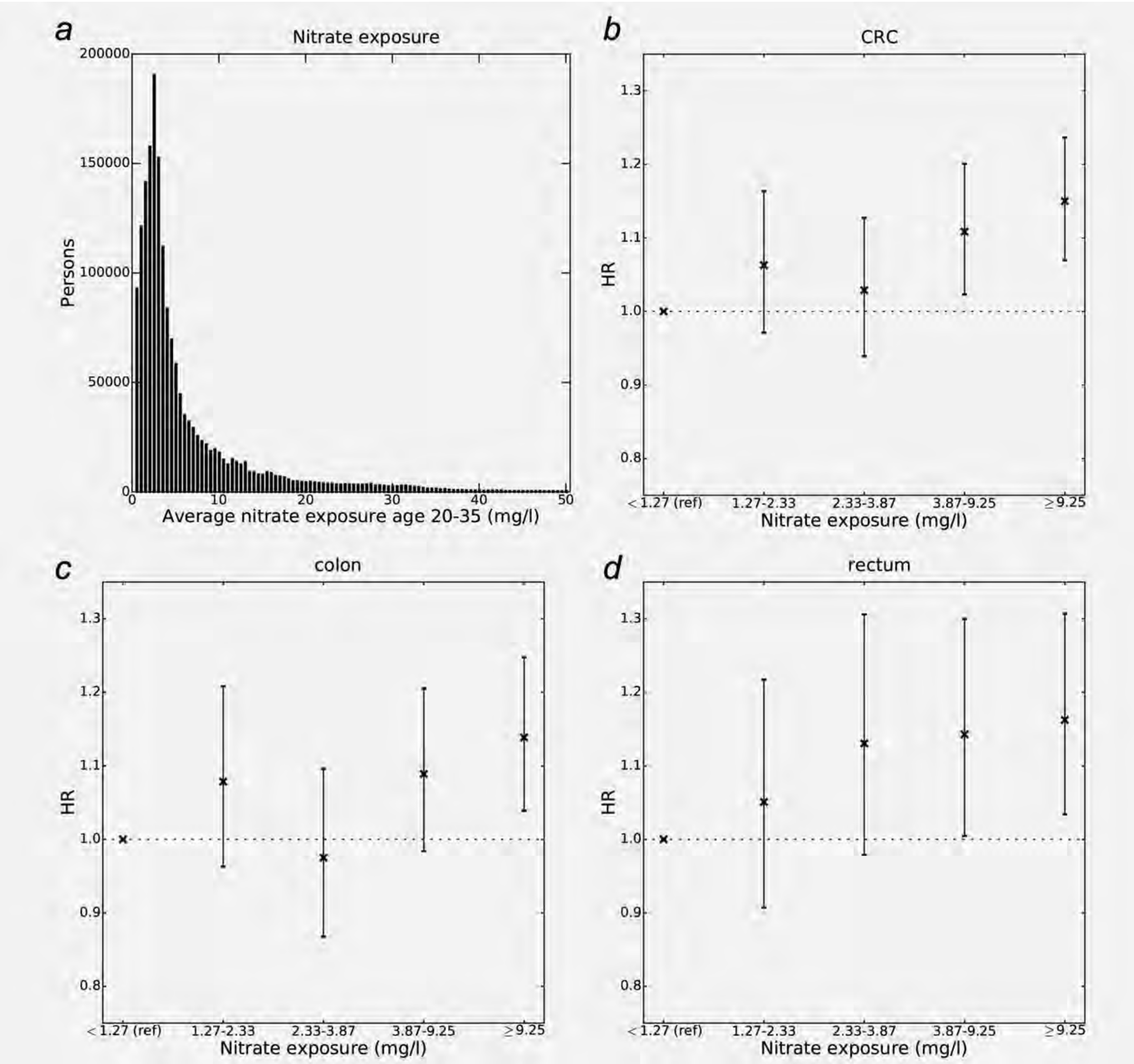

Figure 1. (*a*) Average drinking water nitrate exposure between age 20 and 35 of the study population (subjects exposed to > 50 mg/l [0.58%] not shown here). Hazard ratios (HR) and 95% CIs of nitrate exposure quintiles for (*b*) colorectal, (*c*) colon and (*d*) rectal cancer. Base adjustment.

diagnosis other than the outcome of interest, and *year of birth* in two-year bands to address birth cohort effects.

Statistical analyses

We assessed the association between drinking water nitrate and colon and rectal cancer as separate outcomes, and the combined outcome CRC. We used Cox proportional hazards models to estimate hazard ratios (HRs) using age as the underlying time scale while stratifying the baseline by sex. We included nitrate exposure as quintiles according to the distribution of nitrate exposure in the total population. The base adjustment controlled for age, sex, year of birth and previous cancer diagnosis. Additionally, we adjusted for highest attained education (2nd adjustment). We calculated a summary trend estimate, measuring the effect on a person exposed to the highest decile of nitrate concentrations in drinking water (≥16.75 mg/L) compared with a person exposed to the lowest decile of nitrate concentrations in drinking water (<0.69 mg/L), utilizing data from the in-between deciles (nominal scoring of deciles). Results are reported with 95% confidence intervals (CIs). We checked the validity of the proportional hazards assumption by assessing the null hypothesis of a zero slope of the Schoenfeld residuals on time. Analyses were done in STATA 13.1.

Table 1. Adjusted hazard ratios (95% CIs) associated with high levels of nitrate exposure compared with low levels (trend estimate). Incident cases and study population size (*N*)

Cancer site	*N*[1]	Cases[1]	Base adjustment[2]	Second adjustment[3]
Colorectal	1,742,093	5,944	1.16 (1.08–1.25)	1.14 (1.06–1.23)
Colon	1,742,156	3,700	1.15 (1.05–1.26)	1.14 (1.04–1.26)
Rectum	1,742,255	2,308	1.17 (1.04–1.32)	1.13 (1.00–1.27)

[1]Incident cases for colon and rectal cancer are not mutually exclusive.
[2]Age, sex, year of birth and previous cancer diagnosis.
[3]Base and highest attained education.

Sensitivity analyses

Using the trend estimate, we assessed the robustness of our results considering potential bias due to private well users and quality, length and period of each individual's exposure assessment. We excluded persons with a previous cancer diagnosis other than the outcome of interest and residents of the Capital Region.

Ethical considerations

In keeping with Danish legislation, the Danish Data Protection Agency, the Danish Health Data Authority and Statistics Denmark approved this study.

Results

Of the 2,833,825 Danish residents whose exposure window concurred with the study period, 1,742,321 (61%) met the high exposure assessment quality criterion and were included in the main analyses. Persons who had a diagnosis before initiation of follow-up were excluded (CRC: 228; colon: 165; rectum: 66). The distribution of the average nitrate exposure between age 20 and 35 for this study population is shown in Figure 1a. During the 23 million person-years of follow-up, 5,944 persons were diagnosed with CRC, 3,700 with colon cancer and 2,308 with rectal cancer (Table 1 and Supporting Information, Table 1).

Figure 1 shows the HRs of the nitrate concentration exposure quintiles for (b) CRC, (c) colon and (d) rectal cancer. For both CRC and rectal cancer alone, the two highest exposure quintiles (>3.87 mg/L) showed statistically significant increased HRs. For colon cancer alone, only the highest exposure quintile (≥9.25 mg/L) was associated with a statistically significant increased HR. In the following, we focus on the trend estimate.

Individuals exposed to the highest level of drinking water nitrate (≥16.75 mg/L) had an increased risk of CRC [HR: 1.16 (95% CI: 1.08–1.25)] compared with individuals exposed to the lowest exposure level (<0.69 mg/L; see Table 1, base adjustment). Additional adjustment for education had only limited influence. Similar results were obtained when considering colon and rectal cancer as separate outcomes. Effect modification by sex was not observed (CRC: $p = 0.49$; colon: $p = 0.44$; rectum: $p = 0.99$; second adjustment). Stepwise reincluding individuals with a lower exposure assessment quality increased the study population to ultimately 2,692,508 individuals, followed for ~44 million person-years (Table 2). As exposure assessment quality decreased, the observed effect sizes decreased as well.

Additional sensitivity analyses yielded robust results (Table 3). The proportional hazards assumption was not violated in any of the presented models. A previous cancer diagnosis other than the outcome of interest was associated with increased HRs for all outcomes, and a protective effect of increasing levels of education was observed (results not shown).

Discussion

This is the first nationwide population-based study using a historical longitudinal assessment of long-term drinking water nitrate exposure to assess the associated risk of CRC. Our results showed the higher the level of nitrate in drinking water, the higher the risk of CRC. Considering colon and rectal cancer as separate outcomes, we found similar results. Results for CRC combined and rectal cancer alone showed statistically significant increased HRs in the two highest quintiles of exposure (>3.87 mg/L). For colon cancer, this was only seen in the highest quintile (≥9.25 mg/L), still at concentrations substantially below the current drinking water standard of 50 mg/L. This suggests a need of lowering the drinking water standard to adequately protect the public against chronic adverse health effects of nitrate in drinking water.

From Figure 1, a dose–response relationship is suggested, which is supported by the results for the trend estimate of 1.14 (95% CI: 1.06–1.23) for CRC, 1.14 (1.04–1.26) for colon cancer alone and 1.13 (1.00–1.27) for rectal cancer alone in the full adjustment. Hazard ratios were similar in all adjustments, indicating little influence of the included covariates and sensitivity analyses showed stable and robust results. Interestingly, the higher the exposure assessment quality, the higher effect sizes were observed (Table 2). Lower exposure assessment quality levels were due to interpolation of nitrate concentrations for years with no sample taken at the respective waterworks. Consequently, effect sizes were expected to attenuate with increasing levels of misclassification.[21]

Our results showed a statistically significant positive association between nitrate in drinking water and CRC at levels well below the current drinking water standard, which is in agreement with the findings of a recent case–control study.[15] Espejo-Herrera *et al*. found an increased risk for colon cancer from 5 mg/d waterborne nitrate intake (corresponding to drinking water concentrations of ~4.3 mg/L), and for CRC and rectal cancer from ~8.6 mg/L. Espejo-Herrera *et al*. had individual-level data on endogenous nitrosation factors, diet, lifestyle and water consumption, allowing controlling for established CRC risk factors and additional covariates. They observed higher effect sizes in groups with high red meat intake, in agreement with a previous study.[12]

Table 2. Stepwise reinclusion of individuals with at least 75% of their exposure window at given, or higher, exposure assessment quality level. Trend estimate: hazard ratios (95% CIs), study population size (*N*) and number of cases for colon and rectal cancer. Second adjustment (age, sex, year of birth, previous cancer diagnosis and highest attained education)

Exposure assessment quality	Explanation	N^1	Colon	Rectum
High (main analyses)	At least one nitrate sample taken within 1 year at waterworks supplying the residence[2]	1,742,156	1.14 (1.04–1.26)	1.13 (1.00–1.27)
		Cases	3,700	2,308
Medium high	At least one nitrate sample taken within 5 years at waterworks supplying the residence[2]	2,139,124	1.11 (1.03–1.19)	1.10 (1.01–1.21)
		Cases	6,025	3,764
Medium	At least one nitrate sample taken within 10 years at waterworks supplying the residence[2]	2,299,309	1.08 (1.01–1.16)	1.10 (1.01–1.19)
		Cases	6,966	4,384
Medium low	At least one nitrate sample taken outside time window of 10 years at waterworks supplying the residence[2]	2,615,138	1.09 (1.02–1.16)	1.08 (0.99–1.16)
		Cases	8,652	5,495
Low	No nitrate sample taken at waterworks supplying the residence[2]	2,692,508	1.09 (1.03–1.15)	1.07 (0.99–1.15)
		Cases	8,844	5,618

[1]Study population *N* for colon cancer analyses.
[2]Residence: longitudinal data refers to exposure assessment quality of each individual's residence at any point in time during the exposure window.

Table 3. Sensitivity analyses: hazard ratios (95% CIs) of trend estimate and study size *N*. Full adjustment: age, sex, year of birth, previous cancer diagnosis and education

Scenario	N^1	Colon	Rectum
Main analysis (Table 1)	1,742,156	1.14 (1.04–1.26)	1.13 (1.00–1.27)
Excluding private well users	1,684,944	1.14 (1.04–1.25)	1.13 (1.00–1.27)
At least 5 years of exposure data	1,562,072	1.15 (1.01–1.31)	1.07 (0.90–1.26)
At least 10 years of exposure data	1,351,232	1.18 (0.98–1.41)	1.06 (0.84–1.33)
Only individuals with colon/rectum cancer as first cancer diagnosis	1,681,694	1.13 (1.02–1.25)	1.11 (0.98–1.26)
New exposure window: age 30–40	1,798,350	1.13 (1.05–1.21)	1.07 (0.98–1.18)
Excluding capital region	1,195,094	1.18 (1.06–1.31)	1.09 (0.95–1.25)

[1]Study population *N* for colon cancer analyses.

While we could not include individual-level data on diet and lifestyle, the strength of our study lies in its large population size and the comprehensive long-term exposure assessment. By including the entire population (up to 2.7 million persons followed for up to 34 years), we avoided selection bias. Register data used in this study are deemed to be of very high validity and completeness.[17,19] All administrative, health and drinking water quality data were prospectively collected, thereby eliminating bias due to differential recall and loss to follow-up.

In contrast to previous studies, our exposure assessment was based on exhaustive longitudinal drinking water quality data, registered in one nationwide database. We did not need to model historical nitrate concentrations at the waterworks, but could rely on the actual measurements of nitrate concentrations in drinking water samples taken and analyzed by certified laboratories.[22] We used the physical drinking water supply areas to assign nitrate concentrations to each household and knew the precise residential history of all study participants. Here, our exposure assessment is superior to earlier studies that needed to model historical exposure both spatially and temporally, or estimated exposure by nitrate concentrations at a given location at a single point in time.

Estimating waterborne nitrate intake from residential tap water is reasonable in the Danish context; the annual bottled water consumption is the lowest in Europe with 26 L per person.[23] Furthermore, it has been shown that nitrate levels do not change within a given distribution system and that seasonal variations in drinking water nitrate levels at public supplies are negligible in Denmark.[24] Groundwater abstracted for drinking water production has a typical age (time since recharge) of 10–60 years.[24] We do not have adequate data to assess seasonal variability in private wells. However, seasonal variability in shallow wells has been observed in other locations.[25] Private wells are often shallower than public supply wells; therefore, we cannot exclude seasonal variability in private wells. Since Danish waterworks abstain from using chemical disinfection, confounding by disinfection by-products was not a concern in this study.[26] Water samples used in this study were taken after all treatment steps at the waterworks. The use of in-home water treatment installations to reduce nitrate concentrations is uncommon in Denmark and authorities have been restrictive in giving permission to use such installations at private wells.[27]

The possibility of including information on private wells is another strength of our work. It was earlier shown that the drinking water sampling frequency for private wells is much lower compared to public supplies.[5,18] Therefore, residing a long time at a privately supplied household decreased an individual's exposure assessment quality level. The stepwise inclusion of lower exposure assessment quality levels into the model was therefore crucial to include those who lived many years with private well supply. Even though we could only retrieve nitrate concentrations of approximately half of the 55,752 private wells that we identified,[18] we knew the location of the remaining wells and could therefore exclude their users in our sensitivity analyses.

Given our study design, we were limited to include only covariates available in nationwide registers. We could for example not control for individual-level information on lifestyle and diet. A study on the dietary intake of nitrate in the Danish population estimated an average nitrate intake of 61 mg/d for adults.[28] Therefore, at elevated levels as seen in parts of the Danish population (Figure 1a), drinking water will be a major source of nitrate exposure. As diet (e.g., red meat), alcohol intake, smoking and lifestyle factors such as physical inactivity are established CRC risk factors that we could not include in our analyses, the possibility of confounding our results needs to be considered. To address this issue, we adjusted our analyses for highest attained education, an especially appropriate proxy for lifestyle, smoking and diet in the Danish population.[29] Furthermore, studies suggest that dietary nitrate intake is not associated with CRC, or even has a protective effect, because of antioxidants and nitrosation inhibitors in nitrate-containing foods.[6] Nevertheless, any observational study of human health, including the present, cannot exclude the possibility of residual confounding by unobserved factors.

Another limitation is the omission of drinking water nitrite levels in our models. Nitrite is an intermediate in the endogenous transformation of nitrate into genotoxic *N*-nitroso compounds. Nitrite occurs in groundwater in the anoxic nitrate reducing zone but can also be formed at the waterworks due to oxidation of ammonium. Drinking water samples are historically not measured for nitrite to the same extent as nitrate. The restrictive drinking water standard of 0.01 mg/L nitrite is complied with at the large waterworks[30]; however, little is known for smaller waterworks and private wells. An earlier study showed that even though nitrite is taken up through drinking water and food, up to 77% of the total exposure to nitrite is due to the reduction of nitrate *in vivo*.[31] Furthermore, nitrate in drinking water could also be a proxy for additional agricultural pollutants, such as pesticides, which we did not consider here.

We used the average nitrate concentration an individual was exposed to between their 20th and 35th birthdays as the exposure estimate. We assumed that this exposure period was representative of the relevant relationship between exposure and outcome. As geocoded residences were available from 1978 onward, our main analyses included the early cases of CRC only, with an age at diagnosis below 69, before incidence rates peak. Shifting the exposure window to age 30–40, we could include more cases (until age 74), however, at the expense of moving the exposure closer to the time of disease onset. We observed a high agreement between the estimated nitrate exposures in the two competing exposure models. Changing the exposure window to age 30–40 did not substantially change the associated HRs.

In conclusion, our study adds to the growing body of evidence that suggests an increased risk of CRC at nitrate levels in drinking water below the current drinking water standard. Several studies carried out in different locations with different designs and each of their strengths and limitations imply this association. While our study contributed with a large study population, the resulting statistical power, and a detailed exposure assessment, other studies' strengths lay in the inclusion of a number of additional covariates. Considering all evidence, not only in the light of the precautionary principle, a discussion about a reduction of the drinking water standard is warranted.

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Review

Drinking Water Nitrate and Human Health: An Updated Review

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Abstract: Nitrate levels in our water resources have increased in many areas of the world largely due to applications of inorganic fertilizer and animal manure in agricultural areas. The regulatory limit for nitrate in public drinking water supplies was set to protect against infant methemoglobinemia, but other health effects were not considered. Risk of specific cancers and birth defects may be increased when nitrate is ingested under conditions that increase formation of *N*-nitroso compounds. We previously reviewed epidemiologic studies before 2005 of nitrate intake from drinking water and cancer, adverse reproductive outcomes and other health effects. Since that review, more than 30 epidemiologic studies have evaluated drinking water nitrate and these outcomes. The most common endpoints studied were colorectal cancer, bladder, and breast cancer (three studies each), and thyroid disease (four studies). Considering all studies, the strongest evidence for a relationship between drinking water nitrate ingestion and adverse health outcomes (besides methemoglobinemia) is for colorectal cancer, thyroid disease, and neural tube defects. Many studies observed increased risk with ingestion of water nitrate levels that were below regulatory limits. Future studies of these and other health outcomes should include improved exposure assessment and accurate characterization of individual factors that affect endogenous nitrosation.

Keywords: drinking water; nitrate; cancer; adverse reproductive outcomes; methemoglobinemia; thyroid disease; endogenous nitrosation; *N*-nitroso compounds

1. Introduction

Since the mid-1920s, humans have doubled the natural rate at which nitrogen is deposited onto land through the production and application of nitrogen fertilizers (inorganic and manure), the combustion of fossil fuels, and replacement of natural vegetation with nitrogen-fixing crops such as soybeans [1,2]. The major anthropogenic source of nitrogen in the environment is nitrogen fertilizer, the application of which increased exponentially after the development of the Haber–Bosch process in the 1920s. Most synthetic fertilizer applications to agricultural land occurred after 1980 [3]. Since approximately half of all applied nitrogen drains from agricultural fields to contaminate surface and groundwater, nitrate concentrations in our water resources have also increased [1].

The maximum contaminant level (MCL) for nitrate in public drinking water supplies in the United States (U.S.) is 10 mg/L as nitrate-nitrogen (NO_3-N). This concentration is approximately equivalent to the World Health Organization (WHO) guideline of 50 mg/L as NO_3 or 11.3 mg/L NO_3-N (multiply NO_3 mg/L by 0.2258). The MCL was set to protect against infant methemoglobinemia; however other health effects including cancer and adverse reproductive outcomes were not considered [4]. Through endogenous nitrosation, nitrate is a precursor in the formation of *N*-nitroso compounds (NOC); most NOC are carcinogens and teratogens. Thus, exposure to NOC formed after ingestion of nitrate from drinking water and dietary sources may result in cancer, birth defects, or other adverse health effects. Nitrate is found in many foods, with the highest levels occurring in some green leafy and root vegetables [5,6]. Average daily intakes from food are in the range of 30–130 mg/day as NO_3 (7–29 mg/day NO_3-N) [5]. Because NOC formation is inhibited by ascorbic acid, polyphenols, and other compounds present at high levels in most vegetables, dietary nitrate intake may not result in substantial endogenous NOC formation [5,7].

Studies of health effects related to nitrate exposure from drinking water were previously reviewed through early 2004 [8]. Further, an International Agency for Research on Cancer (IARC) Working Group reviewed human, animal, and mechanistic studies of cancer through mid-2006 and concluded that ingested nitrate and nitrite, under conditions that result in endogenous nitrosation, are probably carcinogenic [5]. Here, our objective is to provide updated information on human exposure and to review mechanistic and health effects studies since 2004. We summarize how the additional studies contribute to the overall evidence for health effects and we discuss what future research may be most informative.

2. Drinking Water Nitrate Exposures in the United States and Europe

Approximately 45 million people in the U.S. (about 14% of the population) had self-supplied water at their residence in 2010 [9]. Almost all (98%) were private wells, which are not regulated by the U.S. Environmental Protection Agency (EPA). The rest of the population was served by public water supplies, which use groundwater, surface water, or both. The U.S. Geological Survey's National Water Quality Assessment (USGS-NAWQA) Project [10] sampled principal groundwater aquifers used as U.S. public and private drinking water supplies in 1988–2015. Nitrate levels in groundwater under agricultural land were about three times the national background level of 1 mg/L NO_3-N (Figure 1) [11]. The mixed land use category mostly had nitrate concentrations below background levels reflecting levels in deeper private and public water supply wells. Based on the NAWQA study, it was estimated that 2% of public-supply wells and 6% of private wells exceeded the MCL; whereas, in agricultural areas, 21% of private wells exceeded the MCL [10]. The USGS-NAWQA study also revealed significant decadal-scale changes in groundwater nitrate concentrations among wells sampled first in 1988–2000 and again in 2001–2010 for agricultural, urban, and mixed land uses [12]. More sampling networks had increases in median nitrate concentration than had decreases.

A study of U.S. public water supplies (PWS) using data from EPA's Safe Drinking Water Information System estimated that the percentage of PWS violating the MCL increased from 0.28 to 0.42% during 1994–2009; most increases were for small to medium PWS (<10,000 population served) using groundwater [13]. As a result of increasing nitrate levels, some PWS have incurred expensive upgrades to their treatment systems to comply with the regulatory level [14–16].

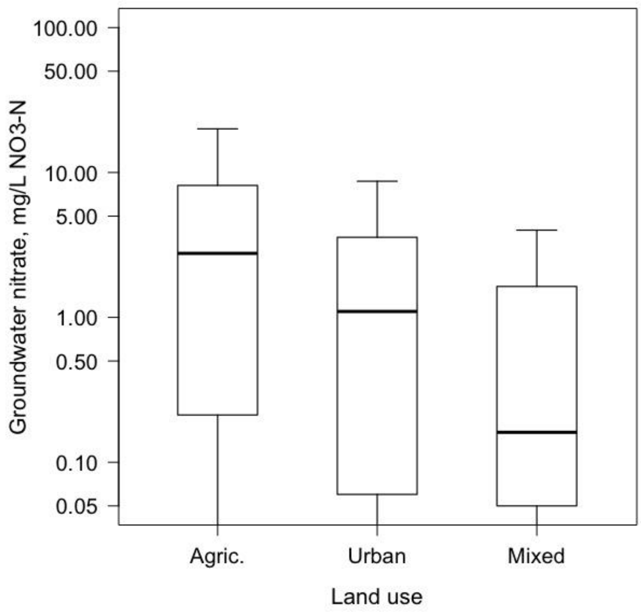

Figure 1. Boxplots of nitrate concentrations in shallow groundwater beneath agricultural and urban land uses, and at depths of private and public drinking water supplies beneath mixed land use. The number of sampled wells were 1573 (agricultural land), 1054 (urban), and 3417 (mixed). The agricultural and urban wells were sampled to assess land use effects, whereas the mixed category wells were sampled at depths of private and public supplies. Median depths of wells in the agricultural, urban, and mixed categories were 34, 32, and 200 feet, respectively. The height of the upper bar is 1.5 times the length of the box, and the lower bound was truncated at the nitrate detection limit of 0.05 mg/L NO_3-N.

In Europe, the Nitrates Directive was set in 1991 [17,18] to reduce or prevent nitrate pollution from agriculture. Areas most affected by nitrate pollution are designated as 'nitrate vulnerable zones' and are subject to mandatory Codes of Good Agricultural Practice [18]. The results of compliance with this directive have been reflected in the time trends of nitrate in some countries. For example, nitrate levels in groundwater in Denmark increased in 1950–1980 and decreased since the 1990s [19]. Average nitrate levels in groundwater in most other European countries have been stable at around 17.5 mg/L NO_3 (4 mg/L NO_3-N) across Europe over a 20-year period (1992–2012), with some differences between countries both in trends and concentrations. Average concentrations are lowest in Finland (around 1 mg/L NO_3 in 1992–2012) and highest in Malta (58.1 mg/L in 2000–2012) [20]. Average annual nitrate concentrations at river monitoring stations in Europe showed a steady decline from 2.7 NO_3-N in 1992 to 2.1 mg/L in 2012 [20], with the lowest average levels in Norway (0.2 mg/L NO_3-N in 2012) and highest in Greece (6.6 mg/L NO_3-N in 2012).

Levels in finished public drinking water have been published only for a few European countries. Trends of nitrate in drinking water supplies from 1976 to 2012 in Denmark showed a decline in public supplies but not in private wells [21]. In Spain, median concentrations were 3.5 mg/L NO_3 (range: 0.4−66.8) in 108 municipalities in 2012 [22], and 4.2 mg/L (range: <1−29) in 11 provinces in 2010 [23]. Levels in other countries included a median of 0.18 mg/L (range: <0.02−7.9) in Iceland in 2001−2012 [24], a mean of 16.1 mg/L (range: 0.05−296 mg/L) in Sicily, Italy in 2004−2005 [25] and a range from undetected to 63.3 mg/L in Deux-Sèvres, France in in 2005−2009 [26].

Nitrate levels in bottled water have been measured in a few areas of the EU and the U.S. and have been found to be below the MCL. In Sicily, the mean level was 15.2 mg/L NO_3(range: 1.2−31.8 mg/L) in 16 brands [25] and in Spain, the median level was 5.2 mg/L NO_3 (range: <1.0−29.0 mg/L) in 9 brands [23]. In the U.S., a survey of bottle water sold in 42 Iowa and 32 Texas communities found varying but generally low nitrate levels. Nitrate concentrations ranged from below the limit of detection (0.1 mg/L NO_3-N) to 4.9 mg/L NO_3-N for U.S. domestic spring water purchased in Texas.

There are few published studies of nitrate concentrations in drinking water outside the U.S. and Europe. Nitrate concentrations in groundwater were reported for Morocco, Niger, Nigeria, Senegal, India-Pakistan, Japan, Lebanon, Philippines and Turkey with maximum levels in Senegal (median 42.9 mg/L NO_3-N) [5]. In India, nitrate in drinking water supplies is particularly high in rural areas, where average levels have been reported to be 45.7 mg/L NO_3 [27,28] and 66.6 mg/L NO_3 [28]; maximum levels in drinking water exceeded 100 mg/L NO_3 in several regions [27,29]. Extremely high levels of nitrate have been reported in The Gaza Strip, where nitrate reached concentrations of 500 mg/L NO_3 in some areas, and more than 50% of public-supply wells had nitrate concentrations above 45 mg/L NO_3 [30].

3. Exposure Assessment in Epidemiologic Studies

With the implementation of the Safe Drinking Water Act in 1974, more than 40 years of monitoring data for public water supplies in the U.S. provide a framework of measurements to support exposure assessments. Historical data for Europe are more limited, but a quadrennial nitrate reporting requirement was implemented as part of the EU Nitrates Directive [17,18]. In the U.S., the frequency of sampling for nitrate in community water systems is stipulated by their sources (ground versus surface waters) and whether concentrations are below the MCL, and historically, by the size of the population served and vulnerability to nitrate contamination. Therefore, the exposure assessment for study participants who report using a public drinking water source may be based on a variable number of measurements, raising concerns about exposure misclassification. In a study of bladder cancer risk in Iowa, associations were stronger in sensitivity analyses based on more comprehensive measurement data [31]. Other studies have restricted analyses to subgroups with more complete or recent measurements [32–35], with implications for study power and possible selection biases. Sampling frequency also limits the extent to which temporal variation in exposure can be represented within a study population, such as the monthly or trimester-based estimates of exposure most relevant for etiologic investigations of adverse reproductive outcomes. In Denmark, limited seasonal variation in nitrate monitoring data suggested these data would sufficiently capture temporal variation for long-term exposure estimates [36]. Studies have often combined regulatory measurements with questionnaire and ancillary data to better characterize individual variation in nitrate exposure, such as to capture changes in water supply characteristics over time or a participant's duration at a drinking water source [31,33,37,38]. Most case-control studies of drinking water nitrate and cancer obtained lifetime residence and drinking water source histories, whereas cohort studies typically have collected only the current water source. Many studies lacked information about study participants' water consumption, which may be an important determinant of exposure to drinking water contaminants [39].

Due to sparse measurement data, exposures for individuals served by private wells are more difficult to estimate than exposures for those on public water supplies. However, advances in geographic-based modeling efforts that incorporate available measurements, nitrogen inputs, aquifer characteristics, and other data hold promise for this purpose. These models include predictor variables describing land use, nitrogen inputs (fertilizer applications, animal feeding operations), soils, geology, climate, management practices, and other factors at the scale of interest. Nolan and Hitt [40] and Messier et al. [41] used nonlinear regression models with terms representing nitrogen inputs at the land surface, transport in soils and groundwater, and nitrate removal by processes such as denitrification, to predict groundwater nitrate concentration at the national scale and for North Carolina, respectively. Predictor variables in the models included N fertilizer and manure, agricultural or forested land use, soils, and, in Nolan and Hitt [40], water-use practices and major geology. Nolan and Hitt [40] reported a training R^2 values of 0.77 for a model of groundwater used mainly for private supplies and Messier, Kane, Bolich and Serre [41] reported a cross-validation testing R^2 value of 0.33 for a point-level private well model. These and earlier regression approaches for groundwater nitrate [42–46] relied on predictor variables describing surficial soils and activities at the land surface, because conditions at depth in the aquifer typically are unknown. Redox conditions in the aquifer and the time since water entered the subsurface (i.e., groundwater age) are two of the most important factors affecting groundwater nitrate, but redox constituents typically are not analyzed, and age is difficult to measure. Even if a well has sufficient data to estimate these conditions, the data must be available for all wells in order to predict water quality in unsampled areas. In most of the above studies, well depth was used as a proxy for age and redox and set to average private or public-supply well depth for prediction.

Recent advances in groundwater nitrate exposure modeling have involved machine-learning methods such as random forest (RF) and boosted regression trees (BRT), along with improved characterization of aquifer conditions at the depth of the well screen (the perforated portion of the well where groundwater intake occurs). Tree-based models do not require data transformation, can fit nonlinear relations, and automatically incorporate interactions among predictors [47]. Wheeler et al. [48] used RF to estimate private well nitrate levels in Iowa. In addition to land use and soil variables, predictor variables included aquifer characteristics at the depth of the well screen, such as total thickness of fine-grained glacial deposits above the well screen, average and minimum thicknesses of glacial deposits near sampled wells, and horizontal and vertical hydraulic conductivities near the wells. Well depth, landscape features, nitrogen sources, and aquifer characteristics ranked highly in the final model, which explained 77% and 38% of the variation in training and hold-out nitrate data, respectively.

Ransom et al. [49] used BRT to predict nitrate concentration at the depths of private and public-supply wells for the Central Valley, California. The model used as input estimates of groundwater age at the depth of the well screen (from MODFLOW/MODPATH models) and depth-related reducing conditions in the groundwater. These estimates were generated by separate models and were available throughout the aquifer. Other MODFLOW-based predictor variables comprised depth to groundwater, and vertical water fluxes and the percent coarse material in the uppermost part of the aquifer where groundwater flow was simulated by MODFLOW. Redox variables were top-ranked in the final BRT model, which also included land use-based N leaching flux, precipitation, soil characteristics, and the MODFLOW-based variables described above. The final model retained 25 of an initial 145 predictor variables considered, had training and hold-out R^2 values of 0.83 and 0.44 respectively, and was used to produce a 3D visualization of nitrate in the aquifer. These studies show that modeling advances and improved characterization of aquifer conditions at depth are increasing our ability to predict nitrate exposure from drinking water supplied by private wells.

4. Nitrate Intake and Endogenous Formation of *N*-Nitroso Compounds

Drinking water nitrate is readily absorbed in the upper gastrointestinal tract and distributed in the human body. When it reaches the salivary glands, it is actively transported from blood into saliva and levels may be up to 20 times higher than in the plasma [50–53]. In the oral cavity 6–7% of the total nitrate can be reduced to nitrite, predominantly by nitrate-reducing bacteria [52,54,55]. The secreted nitrate as well as the nitrite generated in the oral cavity re-enter the gastrointestinal tract when swallowed.

Under acidic conditions in the stomach, nitrite can be protonated to nitrous acid (HNO_2), and subsequently yield dinitrogen trioxide (N_2O_3), nitric oxide (NO), and nitrogen dioxide (NO_2). Since the discovery of endogenous NO formation, it has become clear that NO is involved in a wide range of NO-mediated physiological effects. These comprise the regulation of blood pressure and blood flow by mediating vasodilation [56–58], the maintenance of blood vessel tonus [59], the inhibition of platelet adhesion and aggregation [60,61], modulation of mitochondrial function [62] and several other processes [63–66].

On the other hand, various nitrate and nitrite derived metabolites such as nitrous acid (HNO_2) are powerful nitrosating agents and known to drive the formation of NOC, which are suggested to be the causal agents in many of the nitrate-associated adverse health outcomes. NOC comprise *N*-nitrosamines and *N*-nitrosamides, and may be formed when nitrosating agents encounter *N*-nitrosatable amino acids, which are also from dietary origin. The nitrosation process depends on the reaction mechanisms involved, on the concentration of the compounds involved, the pH of the reaction environment, and further modifying factors, including the presence of catalysts or inhibitors of *N*-nitrosation [66–69].

Endogenous nitrosation can also be inhibited, for instance by dietary compounds like vitamin C, which has the capacity to reduce HNO_2 to NO; and alpha-tocopherol or polyphenols, which can reduce nitrite to NO [54,70–72]. Inhibitory effects on nitrosation have also been described for dietary flavonoids such as quercetin, ferulic and caffeic acid, betel nut extracts, garlic, coffee, and green tea polyphenols [73,74]. Earlier studies showed that the intake of 250 mg or 1 g ascorbic acid per day substantially inhibited *N*-nitrosodimethylamine (NDMA) excretion in 25 women consuming a fish meal rich in amines (nitrosatable precursors) for seven days, in combination with drinking water containing nitrate at the acceptable daily intake (ADI) [75]. In addition, strawberries, garlic juice, and kale juice were shown to inhibit NDMA excretion in humans [76]. The effect of these fruits and vegetables is unlikely to be due solely to ascorbic acid. Using the *N*-nitrosoproline (NPRO) test, Helser et al. [77] found that ascorbic acid only inhibited nitrosamine formation by 24% compared with 41–63% following ingestion of juices (100 mL) made of green pepper, pineapple, strawberry or carrot containing an equal total amount of ascorbic acid.

The protective potential of such dietary inhibitors depends not only on the reaction rates of *N*-nitrosatable precursors and nitrosation inhibitors, but also on their biokinetics, since an effective inhibitor needs to follow gastrointestinal circulation kinetics similar to nitrate [78]. It has been argued that consumption of some vegetables with high nitrate content, can at least partially inhibit the formation of NOC [79–81]. This might apply for green leafy vegetables such as spinach and rocket salad, celery or kale [77] as well as other vegetables rich in both nitrate and natural nitrosation inhibitors. Preliminary data show that daily consumption of one bottle of beetroot juice containing 400 mg nitrate (the minimal amount advised for athletes to increase their sports performances) for one day and seven days by 29 young individuals results in an increased urinary excretion of apparent total nitroso compounds (ATNC), an effect that can only be partially inhibited by vitamin C supplements (1 g per day) [82].

Also, the amount of nitrosatable precursors is a key factor in the formation of NOC. Dietary intakes of red and processed meat are of particular importance [83–87] as increased consumption of red meat (600 vs. 60 g/day), but not white meat, was found to cause a three-fold increase in fecal NOC levels [85]. It was demonstrated that heme iron stimulated endogenous nitrosation [84], thereby providing a possible explanation for the differences in colon cancer risk between red and white meat consumption [88]. The link between meat consumption and colon cancer risk is even stronger for nitrite-preserved processed meat than for fresh meat leading an IARC review to conclude that processed meat is carcinogenic to humans [89].

In a human feeding study [90], the replacement of nitrite in processed meat products by natural antioxidants and the impact of drinking water nitrate ingestion is being evaluated in relation to fecal excretion of NOC, accounting for intakes of meat and dietary vitamin C. A pilot study demonstrated that fecal excretion of ATNC increased after participants switched from ingesting drinking water with low nitrate levels to drinking water with nitrate levels at the acceptable daily intake level of 3.7 mg/kg. The 20 volunteers were assigned to a group consuming either 3.75 g/kg body weight (maximum 300 g per day) red processed meat or fresh (unprocessed) white meat. Comparison of the two dietary groups showed that the most pronounced effect of drinking water nitrate was observed in the red processed meat group. No inhibitory effect of vitamin C intake on ATNC levels in feces was found (unpublished results).

5. Methemoglobinemia

The physiologic processes that can lead to methemoglobinemia in infants under six months of age have been described in detail previously [8,91]. Ingested nitrate is reduced to nitrite by bacteria in the mouth and in the infant stomach, which is less acidic than adults. Nitrite binds to hemoglobin to form methemoglobin, which interferes with the oxygen carrying capacity of the blood. Methemoglobinemia is a life-threatening condition that occurs when methemoglobin levels exceed about 10% [8,91]. Risk factors for infant methemoglobinemia include formula made with water containing high nitrate levels, foods and medications that have high nitrate levels [91,92], and enteric infections [93]. Methemoglobinemia related to high nitrate levels in drinking water used to make infant formula was first reported in 1945 [94]. The U.S. EPA limit of 10 mg/L NO_3-N was set as about one-half the level at which there were no observed cases [95]. The most recent U.S. cases related to nitrate in drinking water were reported by Knobeloch and colleagues in the late 1990s in Wisconsin [96] and were not described in our prior review. Nitrate concentrations in the private wells were about two-times the MCL and bacterial contamination was not a factor. They also summarize another U.S. case in 1999 related to nitrate contamination of a private well and six infant deaths attributed to methemoglobinemia in the U.S. between 1979–1999 only one of which was reported in the literature [96,97]. High incidence of infant methemoglobinemia in eastern Europe has also been described previously [98,99]. A 2002 WHO report on water and health [100] noted that there were 41 cases in Hungary annually, 2913 cases in Romania from 1985–1996 and 46 cases in Albania in 1996.

Results of several epidemiologic studies conducted before 2005 that examined the relationship between nitrate in drinking water and levels of methemoglobin or methemoglobinemia in infants have been described previously [8]. Briefly, nitrate levels >10 mg/L NO_3-N were usually associated with increased methemoglobin levels but clinical methemoglobinemia was not always present. Since our last review, a cross-sectional study conducted in Gaza found elevated methemoglobin levels in infants on supplemental feeding with formula made from well water in an area with the highest mean nitrate concentration of 195 mg/L NO_3 (range: 18–440) compared to an area with lower nitrate concentration (mean: 119 mg/L NO_3; range 18–244) [101]. A cross-sectional study in Morocco found a 22% increased risk of methemoglobinemia in infants in an area with drinking water nitrate >50 mg/L (>11 as NO_3-N) compared to infants in an area with nitrate levels <50 mg/L nitrate [102]. A retrospective cohort study in Iowa of persons (aged 1–60 years) consuming private well water with nitrate levels <10 mg/L NO_3-N found a positive relationship between methemoglobin levels in the blood and the amount of nitrate ingestion [103]. Among pregnant women in rural Minnesota with drinking water supplies that were mostly $\leq$3 mg/L NO_3-N, there was no relationship between water nitrate intake and women's methemoglobin levels around 36 weeks' gestation [104].

6. Adverse Pregnancy Outcomes

Maternal drinking water nitrate intake during pregnancy has been investigated as a risk factor for a range of pregnancy outcomes, including spontaneous abortion, fetal deaths, prematurity, intrauterine growth retardation, low birth weight, congenital malformations, and neonatal deaths. The relation between drinking water nitrate and congenital malformations in offspring has been the most extensively studied, most likely because of the availability of birth defect surveillance systems around the world.

Our earlier review focused on studies of drinking water nitrate and adverse pregnancy outcomes published before 2005 [8]. In that review, we cited several studies on the relation between maternal exposure to drinking water nitrate and spontaneous abortion including a cluster investigation that suggested a positive association [105] and a case-control study that found no association [106]. These studies were published over 20 years ago. In the present review, we were unable to identify any recently published studies on this outcome. In Table 1, we describe the findings of studies published since 2004 on the relation between drinking water nitrate and prematurity, low birthweight, and congenital malformations. We report results for nitrate in the units (mg/L NO_3 or NO_3-N) that were reported in the publications. In a historic cohort study conducted in the Deux-Sèvres district (France), Migeot et al. [26] linked maternal addresses from birth records to community water system measurements of nitrate, atrazine, and other pesticides. Exposure to the second tertile of nitrate (14–27 mg/L NO_3) without detectable atrazine metabolites was associated with small-for-gestational age births (Odds Ratio (OR) 1.74, 95% CI 1.1, 2.8), but without a monotonic increase in risk with exposures. There was no association with nitrate among those with atrazine detected in their drinking water supplies. Within the same cohort, Albouy-Llaty and colleagues did not observe any association between higher water nitrate concentrations (with or without the presence of atrazine) and preterm birth [107].

Stayner and colleagues also investigated the relation between atrazine and nitrate in drinking water and rates of low birth weight and preterm birth in 46 counties in four Midwestern U.S. states that were required by EPA to measure nitrate and atrazine monthly due to prior atrazine MCL violations [108]. The investigators developed county-level population-weighted metrics of average monthly nitrate concentrations in public drinking water supplies. When analyses were restricted to counties with less than 20% private well usage (to reduce misclassification due to unknown nitrate levels), average nitrate concentrations during the pregnancy were associated with increased rates of very low birth weight (<1.5 kg Rate Ratio $(RR)_{\text{per 1 ppm}}$ = 1.17, 95% CI 1.08, 1.25) and very preterm births (<32 weeks $RR_{\text{per 1 ppm}}$ = 1.08, 95% CI 1.02, 1.15) but not with low birth weight or preterm birth overall.

In record-based prevalence study in Perth Australia, Joyce et al. mapped births to their water distribution zone and noted positive associations between increasing tertiles of nitrate levels and prevalence of term premature rupture of membranes (PROM) adjusted for smoking and socioeconomic status [109]. Nitrate concentrations were low; the upper tertile cut point was 0.350 mg/L and the maximum concentration was 1.80 mg/L NO_3-N. Preterm PROM was not associated with nitrate concentrations.

Among studies of drinking water nitrate and congenital malformations, few before 2005 included birth defects other than central nervous system defects [8]. More recently, Mattix et al. [110] noted higher rates of abdominal wall defects (AWD) in Indiana compared to U.S. rates for specific years during the period 1990–2002. They observed a positive correlation between monthly AWD rates and monthly atrazine concentrations in surface waters but no correlation with nitrate levels. Water quality data were obtained from the USGS-NAWQA project that monitors agricultural chemicals in streams and shallow groundwater that are mostly not used as drinking water sources. A case-control study of gastroschisis (one of the two major types of AWD), in Washington State [111] also used USGS-NAWQA measurements of nitrate and pesticides in surface water and determined the distance between maternal residences (zip code centroids) and the closest monitoring site with concentrations above the MCL for nitrate, nitrite, and atrazine. Gastrochisis was not associated with maternal proximity to surface water above the MCL for nitrate (>10 mg/L NO_3-N) or nitrite (>1 mg/L NO_2-N) but there was a positive relationship with proximity to sites with atrazine concentrations above the MCL. In a USA-wide study, Winchester et al. [112] linked the USGS-NAWQA monthly surface water nitrate and pesticide concentrations computed for the month of the last menstrual period with monthly rates of 22 types of birth defects in 1996–2002. Rates of birth defects among women who were estimated to have conceived during April through July were higher than rates among women conceiving in other months. In multivariable models that included nitrate, atrazine, and other pesticides, atrazine (but not nitrate or other pesticides) was associated with several types of anomalies. Nitrate was associated with birth defects in the category of "other congenital anomalies" (OR 1.18, 95% CI 1.14, 1.21); the authors did not specify what defects were included in this category. None of these three studies included local or regional data to support the assumption that surface water nitrate and pesticide concentrations correlated with drinking water exposures to these contaminants.

Using a more refined exposure assessment than the aforementioned studies, Holtby et al. [113] conducted a case-control study of congenital anomalies in an agricultural county in Nova Scotia, Canada. They linked maternal addresses at delivery to municipal water supply median nitrate concentrations and used kriging of monthly measurements from a network of 140 private wells to estimate drinking water nitrate concentrations in private wells. They observed no associations between drinking water nitrate and all birth defects combined for conceptions during 1987–1997. However, the prevalence of all birth defects occurring during 1998–2006 was associated with drinking water nitrate concentrations of 1–5.56 mg/L NO_3-N (OR 2.44, 95% CI 1.05, 5.66) and $\geq$5.56 mg/L (OR 2.25, 95% CI 0.92, 5.52).

None of the studies of congenital anomalies accounted for maternal consumption of bottled water or the quantity of water consumed during the first trimester, the most critical period of organ/structural morphogenesis. Attempting to overcome some of these limitations, Brender, Weyer, and colleagues [38,114] conducted a population-based, case-control study in the states of Iowa and Texas where they: (1) linked maternal addresses during the first trimester to public water utilities and respective nitrate measurements; (2) estimated nitrate intake from bottled water based on a survey of products consumed and measurement of nitrate in the major products; (3) predicted drinking water nitrate from private wells through modeling (Texas only); and (4) estimated daily nitrate ingestion from women's drinking water sources and daily consumption of water. The study populations were participants of the U.S. National Birth Defects Prevention Study [115]. Compared to the lowest tertile of nitrate ingestion from drinking water (<0.91 mg/day NO_3), mothers of babies with spina bifida were twice as likely (95% CI 1.3, 3.2) to ingest $\geq$5 mg/day NO_3 from drinking water than control mothers. Mothers of babies with limb deficiencies, cleft palate, and cleft lip were, respectively, 1.8 (95% CI 1.1, 3.1), 1.9 (95% CI 1.2, 3.1), and 1.8 (95% CI 1.1, 3.1) times more likely to ingest $\geq$5.4 mg/day of water NO_3 than controls. Women were also classified by their nitrosatable drug exposure during the first trimester [116] and by their daily nitrate and nitrite intake based on a food frequency questionnaire [117]. Higher ingestion of drinking water nitrate did not strengthen associations between maternal nitrosatable drug exposure and birth defects in offspring [38]. However, a pattern was observed of stronger associations between nitrosatable drug exposure and selected birth defects for women in the upper two tertiles of total nitrite ingestion that included contributions from drinking water nitrate and dietary intakes of nitrate and nitrite compared to women in the lowest tertile. Higher intake of food nitrate/nitrite was found to also modify the associations of nitrosatable drug exposure and birth defects in this study [118,119] as well as in an earlier study of neural tube defects conducted in south Texas [120]. Multiplicative interactions were observed between higher food nitrate/nitrite and nitrosatable drug exposures for conotruncal heart, limb deficiency, and oral cleft defects [118].

In summary, five out of six studies, conducted since the 1980s of drinking water nitrate and central nervous system defects, found positive associations between higher drinking water nitrate exposure during pregnancy and neural tube defects or central nervous system defects combined [38,120–123]. The sixth study, which did not find a relationship, did not include measures of association, but compared average drinking water nitrate concentrations between mothers with and without neural tube defect-affected births, which were comparable [124].

Table 1. Studies of drinking water nitrate [a] and adverse pregnancy outcomes published January 2005–March 2018.

First Author, Year, Country	Study Design Regional Description	Years of Outcome Ascertainment	Exposure Description	Pregnancy Outcome	Summary of Findings
Albouy-Llaty, 2016 France [107]	Historic cohort study Deux-Sèvres	2005–2010	Measurements of atrazine metabolites and NO_3 in community water systems (263 municipalities) were linked to birth addresses	Preterm birth	No association for >26.99 mg/L vs. <14.13 mg/L NO_3 in community water systems with or without atrazine detections, adjusted for neighborhood deprivation
Brender, 2013 Weyer, 2014 USA [38]	Population-based case-control study Iowa and Texas	1997–2005	Maternal addresses during the first trimester linked to public water utility nitrate measurements; nitrate intake from bottled water estimated with survey and laboratory testing; nitrate from private wells predicted through modeling; nitrate ingestion (NO_3) estimated from reported water consumption	Congenital heart defects Limb deficiencies Neural tube defects Oral cleft defects	$\geq$5 vs. <0.91 mg/day NO_3 from drinking water spina bifida OR = 2.0 (95% CI: 1.3, 3.2) $\geq$5.42 vs. <1.0 mg/day NO_3 from water: limb deficiencies OR = 1.8 (CI: 1.1, 3.1); cleft palate OR = 1.9 (CI: 1.2, 3.1) cleft lip OR = 1.8 (CI: 1.1, 3.1)
Holtby, 2014 Canada [113]	Population-based case-control study Kings County, Nova Scotia	1988–2006	Maternal addresses at delivery linked to municipal water supply median nitrate (NO_3-N) concentrations; nitrate in rural private wells estimated from historic sampling and kriging	Congenital malformations combined into one group	Conceptions in 1987–1997: no association with nitrate concentrations Conceptions in 1998–2006: 1–5.56 mg/L NO_3-N (vs. <1 mg/L) OR = 2.44 (CI: 1.05, 5.66); $\geq$5.56 mg/L OR = 2.25 (CI: 0.92, 5.52)
Joyce, 2008 Australia [109]	Record-based prevalence study Perth	2002–2004	Linked birth residences to 24 water distribution zones; computed average NO_3-N mg/L from historical measurements; independent sampling conducted for 6 zones as part of exposure validation; also evaluated trihalomethanes (THM)	Premature rupture of membranes at term (PROM) (37 weeks' gestation or later)	ORs for tertiles (vs. <0.125 mg/L NO_3-N): 0.125–0.350 mg/L OR = 1.23 (CI: 1.03, 1.52); >0.350 mg/L OR = 1.47 (CI: 1.20, 1.79) No association with THM levels
Mattix, 2007 USA [110]	Ecologic study Indiana	1990–2002	Monthly abdominal wall defect rates linked to monthly surface water nitrate and atrazine concentrations (USGS-NAWQA monitoring data [b])	Abdominal wall birth defects	No correlation observed between nitrate levels in surface water and monthly abdominal wall defects Positive correlation with atrazine levels

Table 1. *Cont.*

First Author, Year, Country	Study Design Regional Description	Years of Outcome Ascertainment	Exposure Description	Pregnancy Outcome	Summary of Findings
Migeot, 2013 France [26]	Historic cohort study Deux-Sèvres	2005–2009	Measurements of atrazine metabolites and NO_3 in community water systems (263 municipalities) were linked to birth addresses	Small-for-gestational age (SGA) births	ORs for tertiles (vs. <14.13 mg/L NO_3) in community water systems with no atrazine detections: 14–27 mg/L OR = 1.74 (CI: 1.10, 2.75); >27 mg/L OR = OR 1.51 (CI: 0.96, 2.4); no association with nitrate when atrazine was detected
Stayner, 2017 USA [108]	Ecologic study 46 counties in Indiana, Iowa, Missouri, and Ohio	2004–2008	Counties had one or more water utility in EPA's atrazine monitoring program; excluded counties with >20% of population on private wells and >300,000 population. Computed county-specific monthly weighted averages of NO_3-N in finished drinking water; exposure metric was average 9 months prior to birth	Preterm birth Low birth weight	Average nitrate not associated with low birth weight and preterm birth Very low birth weight: RR for 1 ppm increase in NO_3-N = 1.17 (CI: 1.08, 1.25); Very preterm birth RR for 1 ppm increase = 1.08 (CI: 1.02, 1.15)
Waller, 2010 USA [111]	Population-based case-control study Washington State	1987–2006	Calculated distance between maternal residence and closest stream monitoring site with concentrations >MCL for NO_3-N, NO_2-N, or atrazine in surface water (USGS-NAWQA data [b])	Gastroschisis	Gastroschisis was not associated with maternal residential proximity to surface water with elevated nitrate (>10 mg/L) or nitrite (>1 mg/L)
Winchester, 2009 USA [112]	Ecologic study USA-wide	1996–2002	Rates of combined and specific birth defects (computed by month of last menstrual period) linked to monthly surface water nitrate concentrations (USGS-NAWQA data [b]); also evaluated atrazine and other pesticides (combined)	Birth defects categorized into 22 groups	Birth defect category "other congenital anomalies": OR for continuous log nitrate = 1.15 (CI: 1.12, 1.18); adjusted for atrazine and other pesticides: OR = 1.18, CI: 1.14, 1.21); No association with other birth defects

Abbreviations: CI, 95% CI confidence interval; OR, odds ratio; RR, rate ratio; USGS-NAWQA, U. S. Geological Survey National Water Quality Assessment; [a] nitrate units are specified as reported in publications. NO_3 can be converted to NO_3-N by multiplying by 0.2258; [b] USGS-NAWQA data for 186 streams in 51 hydrological study areas; streams were not drinking water sources.

7. Cancer

Most early epidemiologic studies of cancer were ecologic studies of stomach cancer mortality that used exposure estimates concurrent with the time of death. Results were mixed, with some studies showing positive associations, many showing no association, and a few showing inverse associations. The results of ecologic studies through 1995 were reviewed by Cantor [125]. Our previous review included ecologic studies of the brain, esophagus, stomach, kidney, ovary, and non-Hodgkin lymphoma (NHL) published between 1999 and 2003 that were largely null [8]. We did not include ecologic studies or mortality case-control studies in this review due to the limitations of these study designs, especially their inability to assess individual-level exposure and dietary factors that influence the endogenous formation of NOC.

Since our review of drinking water nitrate and health in 2005 [8], eight case-control studies and eight analyses in three cohorts have evaluated historical nitrate levels in PWS in relation to several cancers. Nitrate levels were largely below 10 mg/L NO_3-N. Most of these studies evaluated potential confounders and factors affecting nitrosation. Table 2 shows the study designs and results of studies published from 2005 through 2018, including findings from periodic follow-ups of a cohort study of postmenopausal women in Iowa (USA) [31,37,126–129]. In the first analysis of drinking water nitrate in the Iowa cohort with follow-up through 1998, Weyer and colleagues [130] reported that ovarian and bladder cancers were positively associated with the long-term average PWS nitrate levels prior to enrollment (highest quartile average 1955–1988: >2.46 mg/L NO_3-N). They observed inverse associations for uterine and rectal cancer, but no associations with cancers of the breast, colon, rectum, pancreas, kidney, lung, melanoma, non-Hodgkin lymphoma (NHL), or leukemia. Analyses of PWS nitrate concentrations and cancers of the thyroid, breast, ovary, bladder, and kidney were published after additional follow-up of the cohort. The exposure assessment was improved by: (a) the computation of average nitrate levels and years of exposure at or above 5 mg/L NO_3-N, based on time in residence (vs. one long-term PWS average nitrate estimate used by Weyer and colleagues); and (b) by estimation of total trihalomethanes (TTHM) and dietary nitrite intake.

Thyroid cancer was evaluated for the first time after follow-up of the cohort through 2004. A total of 40 cases were identified [37]. Among women with >10 years on PWS with levels exceeding 5 mg/L NO_3-N for five years or more, thyroid cancer risk was 2.6 times higher than that of women whose supplies never exceeded 5 mg/L. With follow-up through 2010, the risk of ovarian cancer remained increased among women in the highest quartile of average nitrate in PWS [129]. Ovarian cancer risk among private well users was also elevated compared to the lowest PWS nitrate quartile. Associations were stronger when vitamin C intake was below median levels with a significant interaction for users of private wells. Overall, breast cancer risk was not associated with water nitrate levels with follow-up through 2008 [128]. Among women with folate intake $\geq$ 400 µg/day, risk was increased for those in the highest average nitrate quintile (Hazard Ratio (HR) = 1.40; 95% CI: = 1.05–1.87) and among private well users (HR = 1.38; 95% CI: = 1.05–1.82), compared to those with the lowest average nitrate quintile. There was no association with nitrate exposure among women with lower folate intake. With follow-up through 2010, there were 130 bladder cancer cases among women who had used PWS >10 years. Risk remained elevated among women with the highest average nitrate levels and was 1.6 times higher among women whose drinking water concentration exceeded 5 mg/L NO_3-N for at least four years [31]. Risk estimates were not changed by adjustment for TTHM, which are suspected bladder cancer risk factors. Smoking, but not vitamin C intake, modified the association with nitrate in water; increased risk was apparent only in current smokers (p-interaction <0.03). With follow-up through 2010, there were 125 kidney cancer cases among women using PWS; risk was increased among those in the 95th percentile of average nitrate (>5.0 mg/L NO_3-N) compared with the lowest quartile (HR = 2.2, 95% CI: 1.2–4.2) [127]. There was no positive trend with the average nitrate level and no increased risk for women using private wells, compared to those with low average nitrate in their public supply. An investigation of pancreatic cancer in the same population (follow-up through 2011) found no association with average water nitrate levels in public supplies and no association among women on private wells [126].

In contrast to the positive findings for bladder cancer among the cohort of Iowa women, a cohort study of men and women aged 55–69 in the Netherlands with lower nitrate levels in PWS found no association between water nitrate ingestion (median in top quintile = 2.4 mg/day NO_3-N) and bladder cancer risk [131]. Dietary intake of vitamins C and E and history of cigarette smoking did not modify the association. A hospital-based case-control study of bladder cancer in multiple areas of Spain [33] assessed lifetime water sources and usual intake of tap water. Nitrate levels in PWS were low, with almost all average levels below 2 mg/L NO_3-N. Risk of bladder cancer was not associated with the nitrate level in drinking water or with estimated nitrate ingestion from drinking water, and there was no evidence of interaction with factors affecting endogenous nitrosation.

Several case-control studies conducted in the Midwestern U.S. obtained lifetime histories of drinking water sources and estimated exposure for PWS users. In contrast to findings of an increased risk of NHL associated with nitrate levels in Nebraska PWS in an earlier study [132], there was no association with similar concentrations in public water sources in a case-control study of NHL in Iowa [35]. A study of renal cell carcinoma in Iowa [34] found no association with the level of nitrate in PWS, including the number of years that levels exceeded 5 or 10 mg/L NO_3-N. However, higher nitrate levels in PWS increased risk among subgroups who reported above the median intake of red meat intake or below the median intake of vitamin C (p-interaction <0.05). A small case-control study of adenocarcinoma of the stomach and esophagus among men and women in Nebraska [133] estimated nitrate levels among long-term users of PWS and found no association between average nitrate levels and risk.

A case-control study of colorectal cancer among rural women in Wisconsin estimated nitrate levels in private wells using spatial interpolation of nitrate concentrations from a 1994 water quality survey and found increased risk of proximal colon cancer among women estimated to have nitrate levels >10 mg/L NO_3-N compared to levels < 0.5 mg/L. Risk of distal colon cancer and rectal cancer were not associated with nitrate levels [134]. Water nitrate ingestion from public supplies, bottled water, and private wells and springs over the adult lifetime was estimated in analyses that pooled case-control studies of colorectal cancer in Spain and Italy [135]. Risk of colorectal cancer was increased among those with >2.3 mg/day NO_3-N (vs. <1.1 mg/day). There were no interactions with red meat, vitamins C and E, and fiber except for a borderline interaction (p-interaction = 0.07) for rectum cancer with fiber intake. A small hospital-based case-control study in Indonesia found that drinking water nitrate levels above the WHO standard (>11.3 mg/L as NO_3-N) was associated with colorectal cancer [136]. A national registry-based cohort study in Denmark [32] evaluated average nitrate concentrations in PWS and private wells in relation to colorectal cancer incidence among those whose 35th birthday occurred during 1978–2011. The average nitrate level was computed over residential water supplies from age 20 to 35. Increased risks for colon and rectum cancer were observed in association with average nitrate levels $\geq$9.25 mg/L NO_3 ($\geq$2.1 as NO_3-N) and $\geq$3.87 mg/L NO_3 (>0.87 as NO_3-N), respectively, with a significant positive trend. Because the study did not interview individuals, it could not evaluate individual-level risk factors that might influence endogenous nitrosation.

A case-control study of breast cancer in Cape Cod, Massachusetts (US) [137] estimated nitrate concentrations in PWS over approximately 20 years as an historical proxy for wastewater contamination and potential exposure to endocrine disruption compounds. Average exposures >1.2 mg/L NO_3-N (vs. <0.3 mg/L) were not associated with risk. A hospital-based case-control study in Spain found no association between water nitrate ingestion and pre- and post-menopausal breast cancers [138].

Table 2. Case-control and cohort studies of drinking water nitrate and cancer (January 2004–March 2018) by cancer site.

First Author (Year) Country	Study Design, Years Regional Description	Exposure Description	Cancer Sites Included	Summary of Drinking-Water Findings [a,b]	Evaluation of Effect Modification [c]
Zeegers, 2006 Netherlands [131]	Cohort Incidence, 1986–1995 204 municipal registries across the Netherlands	1986 nitrate level in 364 pumping stations, exposure data available for 871 cases, 4359 members of the subcohort	Bladder	Highest vs. lowest quintile intake from water ($\geq$1.7 mg/day NO_3-N [median 2.4 mg/day] vs. <0.20) RR = 1.11 (CI: 0.87–1.41; *p*-trend = 0.14)	No interaction with vitamin C, E, smoking
Espejo-Herrera, 2015 Spain [33]	Hospital-based multi-center case-control Incidence, 1998–2001 Asturias, Alicante, Barcelona, Vallès-Bages, Tenerife provinces	Nitrate levels in PWS (1979–2010) and bottled water (measurements of brands with highest consumption based on a Spanish survey); analyses limited to those with $\geq$70% of residential history with nitrate estimate (531 cases, 556 controls)	Bladder	Highest vs. lowest quartile average level (age 18-interview) ($\geq$2.26 vs. 1.13 mg/L NO_3-N) OR = 1.04 (CI: 0.60–1.81) Years >2.15 mg/L NO_3-N (75th percentile) (>20 vs. 0 years) OR = 1.41 (CI: 0.89–2.24)	No interaction with vitamin C, E, red meat, processed meat, average THM level
Jones, 2016 USA [31]	Population-based cohort of postmenopausal women ages 55–69 Incidence, 1986–2010 Iowa	Nitrate levels in PWS (1955–1988) and private well use among women >10 years at enrollment residence with nitrate and trihalomethane estimates (20,945 women; 170 bladder cases); no measurements for private wells Adjusted for total trihalomethanes (TTHM)	Bladder	Highest vs. lowest quartile PWS average ($\geq$2.98 vs. <0.47 mg/L NO_3-N) HR = 1.47 (CI: 0.91–2.38; *p*-trend = 0.11) Years >5 mg/L ($\geq$4 years vs. 0) HR = 1.61 (CI: 1.05–2.47; *p*-trend = 0.03) Private well users (vs. <0.47 mg/L NO_3-N on PWS) HR = 1.53 (CI: 0.93–2.54)	Interaction with smoking (*p*-interaction = 0.03); HR = 3.67 (CI: 1.43–9.38) among current smokers/$\geq$2.98 mg/L vs. non-smokers/<0.47 mg/L NO_3-N); No interaction with vitamin C, TTHM levels
Mueller, 2004 USA, Canada, France, Italy, Spain [139]	Pooled case-control studies Incidence among children <15 years (USA <20 years) 7 regions of 5 countries	Water source during pregnancy and first year of child's life (836 cases, 1485 controls); nitrate test strip measurements of nitrate and nitrite for pregnancy home (except Italy) (283 cases, 537 controls; excluding bottled water users: 207 cases, 400 controls)	Brain, childhood	Private well use versus PWS associated with increased risk in 2 regions and decreased risk in one; No association with nitrate levels in water supplies Astrocytomas (excludes bottled water users): $\geq$1.5 vs. <0.3 mg/L NO_2-N OR = 5.7 (CI: 1.2–27.2)	Not described
Brody, 2006 USA [137]	Case-control Incidence, 1988–1995 Cape Cod, Massachusetts	Nitrate levels in public water supplies (PWS) since 1972 was used as an indicator of wastewater contamination and potential mammary carcinogens and endocrine disrupting compounds; excluded women on private wells	Breast	Average $\geq$1.2 mg/L NO_3-N vs. <0.3 OR = 1.8, (CI: 0.6–5.0); summed annual NO_3-N $\geq$ 10 vs. 1–< 10 mg/L OR = 0.9, CI: 0.6–1.5); number of years >1 mg/L NO_3-N $\geq$8 vs. 0 years OR = 0.9 (CI: 0.5–1.5)	Not described

Table 2. *Cont.*

First Author (Year) Country	Study Design, Years Regional Description	Exposure Description	Cancer Sites Included	Summary of Drinking-Water Findings [a,b]	Evaluation of Effect Modification [c]
Inoue-Choi, 2012 USA [128]	Population-based cohort of postmenopausal women ages 55–69 Incidence, 1986–2008 Iowa	Nitrate levels in PWS (1955–1988) and private well use among women >10 years at enrollment residence (20,147 women; 1751 breast cases); no measurements for private wells	Breast	Highest vs. lowest quintile PWS average (≥3.8 vs. ≤0.32 mg/L NO_3-N) HR = 1.14 (CI: 0.95–1.36; *p*-trend = 0.11); Private well (vs. ≤ 0.32 mg/L NO_3-N) HR = 1.14 (CI: 0.97–1.34); Private well (vs. ≤0.32 mg/L NO_3-N on PWS) HR = 1.38 (CI: 1.05–1.82); No association among those with low folate <400 µg/day	Interaction with folate for PWS (*p*-interaction = 0.06). Folate ≥400 µg/d: (≥3.8 vs. ≤0.32 mg/L NO_3-N) HR = 1.40 (CI: 1.05–1.87; *p*-trend = 0.04)
Espejo-Herrera, 2016 Spain [138]	Hospital-based multi-center case-control Incidence, 2008–2013 Spain (8 provinces)	Nitrate levels in PWS (2004–2010), bottled water measurements and private wells and springs (2013 measurements in 21 municipalities in León, Spain, the area with highest non-PWS use) Analyses include women with ≥70% of period from age 18 to 2 years before interview (1245 cases, 1520 controls)	Breast	Water nitrate intake based on average nitrate levels (age 18 to 2 years prior to interview) and water intake (L/day). Post-menopausal women: >2.0 vs. 0.5 mg/day NO_3-N OR = 1.32 (0.93–1.86); Premenopausal women: >1.4 vs. 0.4 mg/day NO_3-N OR = 1.14 (0.67–1.94)	No interaction with red meat, processed meat, vitamin C, E, smoking for pre- and post-menopausal women
McElroy, 2008 USA [134]	Population-based case-control, women Incidence, 1990–1992 and 1999–2001 Wisconsin	Limited to women in rural areas with no public water system (475 cases, 1447 controls); nitrate levels at residence (presumed to be private wells) estimated by kriging using data from a 1994 representative sample of 289 private wells	Colorectal	All colon cancers: Private wells ≥10.0 mg/L NO_3-N vs. <0.5 OR = 1.52 (CI: 0.95–2.44); Proximal colon cancer: OR = 2.91 (CI: 1.52–5.56)	Not described
Espejo-Herrera, 2016 Spain, Italy [135]	Multi-center case-control study Incidence, 2008–2013 Spain (9 provinces) and population-based controls; Italy (two provinces) and hospital-based controls	Nitrate levels in PWS (2004–2010) for 349 water supply zones, bottled water (measured brands with highest consumption), and private wells and springs (measurements in 2013 in 21 municipalities in León, Spain, the area with highest non-PWS use) Analyses include those with nitrate estimates for ≥70% of period 30 years before interview (1869 cases, 3530 controls)	Colorectal	Water nitrate intake based on average nitrate levels (estimated 30 to 2 years prior to interview) and water intake (L/day) Highest vs. lowest exposure quintiles (≥2.3 vs. <1.1 mg /day NO_3-N) OR = 1.49 (CI:1.24–1.78); Colon OR = 1.52 (CI: 1.24–1.86), Rectum OR = 1.62 (CI: 1.23–2.14)	Interaction with fiber for rectum (*p*-interaction = 0.07); >20 g/day fiber + >1.0 mg/L NO_3-N vs. <20 g/day + ≤1.0 mg/L HR = 0.72 (CI: 0.52–1.00). No interaction with red meat, vitamin C, E

Table 2. *Cont.*

First Author (Year) Country	Study Design, Years Regional Description	Exposure Description	Cancer Sites Included	Summary of Drinking-Water Findings [a,b]	Evaluation of Effect Modification [c]
Fathmawati, 2017 Indonesia [136]	Hospital-based case-control Incidence, 2014–2016 Indonesia (3 provinces)	Nitrate levels in well water collected during the raining season (Feb-March 2016) and classified based on >11.3 or ≤11.3 mg/L as NO_3-N and duration of exposure >10 and ≤10 years Analyses included participants who reported drinking well water (75 cases, 75 controls)	Colorectal	Water nitrate > WHO standard vs. below (> 11.3 vs. ≤11.3 mg/L NO_3-N) OR = 2.82 (CI: 1.08–7.40); > 10 years: 4.31 (CI: 11.32–14.10); ≤10 years: 1.41 (CI: 0.14–13.68)	Not described
Schullehner, 2018 Denmark [32]	Population-based record-linkage cohort of men and women ages 35 and older, 1978–2011 Denmark	Nitrate levels in PWS and private wells among 1,742,321 who met exposure assessment criteria (5944 colorectal cancer cases, including 3700 with colon and 2308 with rectal cancer)	Colorectal	Annual average nitrate exposure between ages 20–35 among those who lived ≥75% of study period at homes with a water sample within 1 year (61% of Danish population). Highest vs. lowest exposure quintile (≥2.1 vs. 0.16 mg/L NO_3-N); Colorectal: HR = 1.16 (CI: 1.08–1.25); colon: 1.15 (CI: 1.05–1.26); rectum: 1.17 (CI: 1.04–1.32)	No information on dietary intakes or smoking
Ward, 2007 USA [34]	Population-based case control Incidence, 1986–1989 Iowa	Nitrate levels in PWS among those with nitrate estimates for ≥70% of person-years ≥1960 (201 cases, 1244 controls)	Kidney (renal cell carcinomas)	Highest vs. lowest quartile PWS average (≥2.8 mg/L NO_3-N vs. <0.62) OR = 0.89 (CI 0.57–1.39); Years >5mg/L NO_3-N 11+ vs. 0 OR = 1.03 (CI: 0.66–1.60)	Interaction with red meat intake (*p*-interaction = 0.01); OR = 1.91 (CI 1.04–3.51) among 11+ years >5 mg/L NO_3-N and red meat ≥1.2 servings/day. Interaction with vitamin C showed similar pattern (*p*-interaction = 0.13)
Jones, 2017 USA [127]	Population-based cohort of postmenopausal women ages 55–69 Incidence, 1986–2010 Iowa	Nitrate levels in PWS (1955–1988) and private well use among women >10 years at enrollment residence. PWS measurements for nitrate and TTHM; no measurements for private wells (20,945 women; 163 kidney cases)	Kidney	Nitrate and TTHM metrics computed for duration at water source (11+ years) 95th percentile vs. lowest quartile PWS average (≥5.00 vs. <0.47 mg/L NO_3-N) HR = 2.23 (CI: 1.19–4.17; *p*-trend = 0.35) Years >5 mg/L (≥4 years vs. 0) HR = 1.54 (CI: 0.97–2.44; *p*-trend = 0.09) Private well users (vs. <0.47 mg/L NO_3-N in PWS) HR = 0.96 (CI: 0.59–1.58)	No interaction with smoking, vitamin C
Ward, 2006 USA [35]	Population-based case-control Incidence, 1998–2000 Iowa	Nitrate levels in PWS among those with nitrate estimates for ≥70% of person-years ≥1960 (181 case, 142 controls); nitrate measurements for private well users at time of interviews (1998–2000; 54 cases, 44 controls)	Non-Hodgkin lymphoma	Private wells: >5.0 mg/L NO_3-N vs. ND OR = 0.8 (CI 0.2–2.5) PWS average: ≥2.9 mg/L NO_3-N vs. <0.63 OR = 1.2 (CI 0.6–2.2) Years ≥5mg/L NO3-N: 10+ vs. 0 OR = 1.4 (CI: 0.7–2.9)	No interaction with vitamin C, smoking

Table 2. *Cont.*

First Author (Year) Country	Study Design, Years Regional Description	Exposure Description	Cancer Sites Included	Summary of Drinking-Water Findings [a,b]	Evaluation of Effect Modification [c]
Inoue-Choi, 2015 USA [129]	Population-based cohort of postmenopausal women ages 55–69 Incidence, 1986–2010 Iowa	Nitrate levels in PWS (1955–1988) and private well use among women >10 years at enrollment residence; PWS measurements for nitrate and TTHM; no measurements for private wells (17,216 women; 190 ovarian cases)	Ovary	Nitrate and TTHM metrics computed for reported duration at water source (11+ years) Highest vs. lowest quartile PWS average ($\geq$2.98 mg/L vs. <0.47 mg/L NO_3-N) HR = 2.03 (CI = 1.22–3.38; *p*-trend = 0.003) Years >5 mg/L ($\geq$4 years vs. 0) HR = 1.52 (CI: 1.00–2.31; *p*-trend = 0.05) Private well users (vs. <0.47 mg/L NO_3-N in PWS) HR = 1.53 (CI: 0.93–2.54)	No interaction with vitamin C, red meat intake, smoking for PWS nitrate Interaction with private well use and vitamin C intake (*p*-interaction = 0.01)
Quist, 2018 USA [126]	Population-based cohort of postmenopausal women ages 55–69 Incidence, 1986–2011 Iowa	Nitrate levels in PWS (1955–1988) and private well use among women >10 years at enrollment residence; nitrate and TTHM estimates for PWS (20,945 women; 189 pancreas cases); no measurements for private wells Adjusted for TTHM (1955–1988), measured levels in 1980s, prior year levels estimated by expert)	Pancreas	Nitrate and TTHM metrics computed for reported duration at water source (11+ years) 95th percentile vs. lowest quartile PWS average ($\geq$5.69 vs. <0.47 mg/L NO_3-N) HR = 1.16 (CI: 0.51–2.64; *p*-trend = 0.97) Years >5 mg/L ($\geq$4 years vs. 0) HR = 0.90 (CI: 0.55–1.48; *p*-trend = 0.62) Private well users (vs. <0.47 mg/L NO_3-N) HR = 0.92 (CI: 0.55–1.52)	No interaction with smoking, vitamin C
Ward, 2008 USA [133]	Population-based case control Incidence, 1988–1993 Nebraska	Controls from prior study of lymphohematopoetic cases and controls interviewed in 1992–1994; Proxy interviews for 80%, 76%, 61% of stomach, esophagus, controls, respectively. Nitrate levels (1965–1985) in PWS for $\geq$70% of person-years (79 distal stomach, 84, esophagus, 321 controls); Private well users sampling at interview (15 stomach, 22 esophagus, 44 controls)	Stomach and esophagus (adenocarcinomas)	Highest vs. lowest quartile PWS average (>4.32 vs. <2.45 mg/L NO_3-N): stomach OR = 1.2 (CI 0.5–2.7); esophagus OR = 1.3 (CI: 0.6–3.1); Years >10 mg/L NO_3-N (9+ vs. 0): stomach OR = 1.1 (CI: 0.5–2.3); esophagus OR = 1.2 (CI: 0.6–2.7) Private well users (>4.5 mg/L NO_3-N vs. <0.5) stomach OR = 5.1 (CI: 0.5–52; 4 cases, 13 controls); esophagus OR = 0.5 (CI: 0.1–2.9; 8 cases; 13 controls)	No interaction with vitamin C, processed meat, or red meat for either cancer
Ward, 2010 USA [37]	Population-based cohort of postmenopausal women ages 55–69 Incidence, 1986–2004 Iowa	Nitrate levels in PWS (1955–1988) and private well use among women >10 years at enrollment residence (21,977 women; 40 thyroid cases); no measurements for private wells	Thyroid	Highest vs. lowest quartile PWS average (>2.46 vs. <0.36 mg/L NO_3-N) HR = 2.18 (CI: 0.83–5.76; *p*-trend = 0.02) Years >5 mg/L ($\geq$5 years vs. 0) HR = 2.59 (CI: 1.09–6.19; *p*-trend = 0.04); Private well (vs. <0.36 mg/L NO_3-N on PWS) HR = 1.13 (CI: 0.83–3.66) Dietary nitrate intake quartiles positively associated with risk (*p*-trend = 0.05)	No interaction with smoking, vitamin C, body mass index, education, residence location (farm/rural vs. urban)

ND = not detected; PWS = public water supplies; [a] nitrate or nitrite levels presented in the publications as mg/L of the ion were converted to mg/L as NO_3-N or NO_2-N; [b] Odds ratios (OR) for case-control studies, incidence rate ratios (RR) and hazard ratios (HR) for cohort studies, and 95% confidence intervals (CI); [c] Factors evaluated are noted. Interaction refers to reported $p \leq 0.10$ from test of heterogeneity.

Animal studies demonstrate that in utero exposure to nitrosamides can cause brain tumors in the exposed offspring. Water nitrate and nitrite intake during pregnancy was estimated in a multi-center case-control study of childhood brain tumors in five countries based on the maternal residential water source [139]. Results for the California and Washington State sites were reported in our previous review [8,140]. Nitrate/nitrite levels in water supplies were measured using a nitrate test strip method in four countries including these U.S. sites; most of these measurements occurred many years after the pregnancy. Measured nitrate concentrations were not associated with risk of childhood brain tumors. However, higher nitrite levels (>1.5 mg/L NO_2-N) in the drinking water were associated with increased risk of astrocytomas.

8. Thyroid Disease

Animal studies demonstrate that ingestion of nitrate at high doses can competitively inhibit iodine uptake and induce hypertrophy of the thyroid gland [141]. An early study of women in the Netherlands consuming water with nitrate levels at or above the MCL, found increased prevalence of thyroid hypertrophy [142]. Since the last review, five studies have evaluated nitrate ingestion from drinking water (the Iowa cohort study also assessed diet) and prevalence of thyroid disease. A study of school-age children in Slovakia found increased prevalence of subclinical hypothyroidism among children in an area with high nitrate levels (51–274 mg/L NO_3) in water supplies compared with children ingesting water with nitrate $\leq$50 mg/L (11 mg/L NO_3-N). In Bulgarian villages with high nitrate levels (75 mg/L NO_3) and low nitrate levels (8 mg/L), clinical examinations of the thyroids of pregnant women and school children revealed an approximately four- and three-fold increased prevalence of goiter, respectively, in the high nitrate village [143,144]. The iodine status of the populations in both studies was adequate. Self-reported hypothyroidism and hyperthyroidism among a cohort of post-menopausal women in Iowa was not associated with average nitrate concentrations in PWS [37]. However, dietary nitrate, the predominant source of intake, was associated with increased prevalence of hypothyroidism but not hyperthyroidism. Modeled estimates of nitrate concentrations in private wells among a cohort of Old Order Amish in Pennsylvania (USA) were associated with increased prevalence of subclinical hypothyroidism as determined by thyroid stimulating hormone measurements, among women but not men [145].

9. Other Health Effects

Associations between nitrate in drinking water and other non-cancer health effects, including type 1 childhood diabetes (T1D), blood pressure, and acute respiratory tract infections in children were previously reviewed [8]. Since 2004, a small number of studies have contributed additional mixed evidence for these associations. Animal studies indicate that NOC may play a role in the pathology of T1D through damage to pancreatic beta cells [146]. A registry-based study in Finland [147] found a positive trend in T1D incidence with levels of nitrate in drinking water. In contrast, an ecological analysis in Italy showed an inverse correlation with water nitrate levels and T1D rates [148]. A small T1D case-control study in Canada with 57 cases showed no association between T1D and estimated intake of nitrate from drinking water (highest quartile >2.7 mg/day NO_3-N) [149]. Concentrations of nitrate in drinking water (median ~2.1 mg/L NO_3-N) were not associated with progression to T1D in a German nested case-control study of islet autoantibody-positive children, who may be at increased risk of the disease [150].

In a prospective, population-based cohort study in Wisconsin (USA), increased incidence of early and late age-related macular degeneration was positively associated with higher nitrate levels ($\geq$5 mg/L vs. <5 mg/L NO_3-N) in rural private drinking water supplies [151]. The authors suggested several possible mechanisms, including methemoglobin-induced lipid peroxidation in the retina.

Potential benefits of nitrate ingestion include lowering of blood pressure due to production of nitric oxide in the acidic stomach and subsequent vasodilation, antithrombotic, and immunoregulatory effects [152]. Experimental studies in animals and controlled feeding studies in humans have demonstrated mixed evidence of these effects and on other cardiovascular endpoints such as vascular hypertrophy, heart failure, and myocardial infarction (e.g., [152–154]). Ingested nitrite from diet has also been associated with increased blood flow in certain parts of the brain [155]. Epidemiologic studies of these effects are limited to estimation of dietary exposures or biomarkers that integrate exposures from nitrate from diet and drinking water. Recent findings in the Framingham Offspring Study suggested that plasma nitrate was associated with increased overall risk of death that attenuated when adjusted for glomerular function (HR: 1.16, 95% CI: 1.0–1.35) but no association was observed for incident cardiovascular disease [156]. No epidemiologic studies have specifically evaluated nitrate ingested from drinking water in relation to these outcomes. Another potential beneficial effect of nitrate is protection against bacterial infections via its reduction to nitrite by enteric bacteria. In an experimental inflammatory bowel disease mouse model, nitrite in drinking water was associated with both preventive and therapeutic effects [157]. However, there is limited epidemiologic evidence for a reduced risk of gastrointestinal disease in populations with high drinking water nitrate intake. One small, cross-sectional study in Iran found no association between nitrate levels in public water supplies with mean levels of ~5.6 mg/L NO_3-N and gastrointestinal disease [158].

10. Discussion

Since our last review of studies through 2004 [8], more than 30 epidemiologic studies have evaluated drinking water nitrate and risk of cancer, adverse reproductive outcomes, or thyroid disease. However, the number of studies of any one outcome was not large and there are still too few studies to allow firm conclusions about risk. The most common endpoints studied were colorectal cancer, bladder, and breast cancer (three studies each) and thyroid disease (four studies). Considering all studies to date, the strongest evidence for a relationship between drinking water nitrate ingestion and adverse health outcomes (besides methemoglobinemia) is for colorectal cancer, thyroid disease, and neural tube defects. Four of the five published studies of colorectal cancer found evidence of an increased risk of colorectal cancer or colon cancer associated with water nitrate levels that were mostly below the respective regulatory limits [32,134,135,159]. In one of the four positive studies [159], increased risk was only observed in subgroups likely to have increased nitrosation. Four of the five studies of thyroid disease found evidence for an increased prevalence of subclinical hypothyroidism with higher ingestion of drinking water nitrate among children, pregnant women, or women only [37,144,145,160]. Positive associations with drinking water nitrate were observed at nitrate concentrations close to or above the MCL. The fifth study, a cohort of post-menopausal women in Iowa, had lower drinking water nitrate exposure but observed a positive association with dietary nitrate [37]. To date, five of six studies of neural tube defects showed increased risk with exposure to drinking water nitrate below the MCL. Thus, the evidence continues to accumulate that higher nitrate intake during the pregnancy is a risk factor for this group of birth defects.

All but one of the 17 cancer studies conducted since 2004 were in the U.S. or Europe, the majority of which were investigations of nitrate in regulated public drinking water. Thyroid cancer was studied for the first time [37] with a positive finding that should be evaluated in future studies. Bladder cancer, a site for which other drinking water contaminants (arsenic, disinfection by-products [DBPs]) are established or suspected risk factors, was not associated with drinking water nitrate in three of the four studies. Most of the cancer studies since 2004 evaluated effect modification by factors known to influence endogenous nitrosation, although few observed evidence for these effects. Several studies of adverse reproductive outcomes since 2004 have indicated a positive association between maternal prenatal exposure to nitrate concentrations below the MCL and low birth weight and small for gestational age births. However, most studies did not account for co-exposure to other water contaminants, nor did they adjust for potential risk factors. The relation between drinking water nitrate and spontaneous abortion continues to be understudied. Few cases of methemoglobinemia, the health concern that lead to the regulation of nitrate in public water supplies, have been reported in the U.S. since the 1990s. However, as described by Knobeloch et al. [96], cases may be underreported and only a small proportion of cases are thoroughly investigated and described in the literature. Based on published reports, [100] areas of the world of particular concern include several eastern European countries, Gaza, and Morocco, where high nitrate concentrations in water supplies have been linked to high levels of methemoglobin in children. Therefore, continued surveillance and education of physicians and parents will be important. Biological plausibility exists for relationships between nitrate ingestion from drinking water and a few other health outcomes including diabetes and beneficial effects on the cardiovascular system, but there have been only a limited number of epidemiologic studies.

Assessment of drinking water nitrate exposures in future studies should be improved by obtaining drinking water sources at home and at work, estimating the amount of water consumed from each source, and collecting information on water filtration systems that may impact exposure. These efforts are important for reducing misclassification of exposure. Since our last review, an additional decade of PWS monitoring data are available in the U.S. and European countries, which has allowed assessment of exposure over a substantial proportion of participants' lifetimes in recent studies. Future studies should estimate exposure to multiple water contaminants as has been done in recent cancer studies [31,33,127,129]. For instance, nitrate and atrazine frequently occur together in drinking water in agricultural areas [161] and animal studies have found this mixture to be teratogenic [162]. Regulatory monitoring data for pesticides in PWS has been available for over 20 years in the U.S.; therefore, it is now feasible to evaluate co-exposure to these contaminants. Additionally, water supplies in agricultural areas that rely on alluvial aquifers or surface water often have elevated levels of both DBPs and nitrate. Under this exposure scenario, there is the possibility of formation of the nitrogenated DBPs including the carcinogenic NDMA, especially if chloramination treatment is used for disinfection [163,164]. Studies of health effects in countries outside the U.S. and Europe are also needed.

A comprehensive assessment of nitrate and nitrite from drinking water and dietary sources as well as estimation of intakes of antioxidants and other inhibitors of endogenous nitrosation including dietary polyphenols and flavonoids is needed in future studies. Heme iron from red meat, which increases fecal NOC in human feeding studies, should also be assessed as a potential effect modifier of risk from nitrate ingestion. More research is needed on the potential interaction of nitrate ingestion and nitrosatable drugs (those with secondary and tertiary amines or amides). Evidence from several studies of birth defects [38,118–120] implicates nitrosatable drug intake during pregnancy as a risk factor for specific congenital anomalies especially in combination with nitrate. Drugs with nitrosatable groups include many over-the-counter and prescription drugs. Future studies with electronic medical records and record-linkage studies in countries like Denmark with national pharmacy data may provide opportunities for evaluation of these exposures.

Populations with the highest exposure to nitrate from their drinking water are those living in agricultural regions, especially those drinking water from shallow wells near nitrogen sources (e.g., crop fields, animal feeding operations). Estimating exposure for private well users is important because it allows assessment of risk over a greater range of nitrate exposures compared to studies focusing solely on populations using PWS. Future health studies should focus on these populations, many of which may have been exposed to elevated nitrate in drinking water from early childhood into adulthood. A major challenge in conducting studies in these regions is the high prevalence of private well use with limited nitrate measurement data for exposure assessment. Recent efforts to model nitrate concentrations in private wells have shown that it is feasible to develop predictive models where sufficient measurement data are available [41,48,49]. However, predictive models from one area are not likely to be directly translatable to other geographic regions with different aquifers, soils, and nitrogen inputs.

Controlled human feeding studies have demonstrated that endogenous nitrosation occurs after ingestion of drinking water with nitrate concentrations above the MCL of 10 mg/L NO_3-N (~44 mg/L as NO_3). However, the extent of NOC formation after ingestion of drinking water with nitrate concentrations below the MCL has not been well characterized. Increased risks of specific cancers and central nervous system birth defects in study populations consuming nitrate below the MCL is indirect evidence that nitrate ingestion at these levels may be a risk factor under some conditions. However, confounding by other exposures or risk factors can be difficult to rule out in many studies. Controlled human studies to evaluate endogenous nitrosation at levels below the MCL are needed to understand interindividual variability and factors that affect endogenous nitrosation at drinking water nitrate levels below the MCL.

A key step in the endogenous formation of NOC is the reduction of nitrate, which has been transported from the bloodstream into the saliva, to nitrite by the nitrate-reducing bacteria that are located primarily in the crypts on the back of the tongue [165–167]. Tools for measuring bacterial DNA and characterizing the oral microbiome are now available and are currently being incorporated into epidemiologic studies [168,169]. Buccal cell samples that have been collected in epidemiologic studies can be used to characterize the oral microbiome and to determine the relative abundance of the nitrate-reducing bacteria. Studies are needed to characterize the stability of the nitrate-reducing capacity of the oral microbiome over time and to determine factors that may modify this capacity such as diet, oral hygiene, and periodontal disease. Interindividual variability in the oral nitrate-reducing bacteria may play an important role in modifying endogenous NOC formation. The quantification of an individual's nitrate-reducing bacteria in future epidemiologic studies is likely to improve our ability to classify participants by their intrinsic capacity for endogenous nitrosation.

In addition to characterizing the oral microbiome, future epidemiologic studies should incorporate biomarkers of NOC (e.g., urinary or fecal NOC), markers of genetic damage, and determine genetic variability in NOC metabolism. As many NOC require α-hydroxylation by CYP2E1 for bioactivation and for formation of DNA adducts, it is important to investigate the influence of polymorphisms in the gene encoding for this enzyme. Studies are also needed among populations with medical conditions that increase nitrosation such as patients with inflammatory bowel disease and periodontal disease [8]. Because NOC exposures induce characteristic gene expression profiles [170,171], further studies linking drinking water intake to NOC excretion and gene expression responses are relevant to our understanding of health risks associated with drinking water nitrate. The field of 'Exposome-research' [172,173] generates large numbers of genomics profiles in human population studies for which dietary exposures and biobank materials are also available. These studies provide opportunities to measure urinary levels of nitrate and NOC that could be associated with molecular markers of exposure and disease risk.

Nitrate concentrations in global water supplies are likely to increase in the future due to population growth, increases in nitrogen fertilizer use, and increasing intensity and concentration of animal agriculture. Even with increased inputs, mitigation of nitrate concentrations in water resources is possible through local, national, and global efforts. Examples of the latter are the International Nitrogen Initiative [174] and the EU Nitrates Directive [17,18], which aim to quantify human effects on the nitrogen cycle and to validate and promote methods for sustainable nitrogen management. Evidence for the effectiveness of these efforts, which include the identification of vulnerable areas, establishment of codes of good agricultural practices, and national monitoring and reporting are indicated by decreasing trends in groundwater nitrate concentrations in some European countries after the implementation of the EU Nitrates Directive [19]. However, the effect of this initiative was variable across the EU. In the U.S., nitrogen applications to crop fields are not regulated and efforts to reduce nitrogen runoff are voluntary. Although strategies such as appropriate timing of fertilizer applications, diversified crop rotations, planting of cover crops, and reduced tillage can be effective [175], concentrations in U.S. ground and surface water have continued to increase in most areas [10]. Climate change is expected to affect nitrogen in aquatic ecosystems and groundwater through alterations of the hydrological cycle [176]. Climatic factors that affect nitrate in groundwater include the amount, intensity, and timing of precipitation. Increasing rainfall intensity, especially in the winter and spring, can lead to increases in nitrogen runoff from agricultural fields and leaching to groundwater.

11. Conclusions

In summary, most adverse health effects related to drinking water nitrate are likely due to a combination of high nitrate ingestion and factors that increase endogenous nitrosation. Some of the recent studies of cancer and some birth defects have been able to identify subgroups of the population likely to have greater potential for endogenous nitrosation. However, direct methods of assessing these individuals are needed. New methods for quantifying the nitrate-reducing bacteria in the oral microbiome and characterizing genetic variation in NOC metabolism hold promise for identifying high risk groups in epidemiologic studies.

To date, the number of well-designed studies of individual health outcomes is still too few to draw firm conclusions about risk from drinking water nitrate ingestion. Additional studies that incorporate improved exposure assessment for populations on PWS, measured or predicted exposure for private well users, quantification of nitrate-reducing bacteria, and estimates of dietary and other factors affecting nitrosation are needed. Studies of colorectal cancer, thyroid disease, and central nervous system birth defects, which show the most consistent associations with water nitrate ingestion, will be particularly useful for clarifying these risks. Future studies of other health effects with more limited evidence of increased risk are also needed including cancers of the thyroid, ovary, and kidney, and the adverse reproductive outcomes of spontaneous abortion, preterm birth, and small for gestational age births.

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Nitrate and nitrite ingestion and risk of ovarian cancer among postmenopausal women in Iowa

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Nitrate and nitrite are precursors in the endogenous formation of *N*-nitroso compounds (NOC), potential human carcinogens. We evaluated the association of nitrate and nitrite ingestion with postmenopausal ovarian cancer risk in the Iowa Women's Health Study. Among 28,555 postmenopausal women, we identified 315 incident epithelial ovarian cancers from 1986 to 2010. Dietary nitrate and nitrite intakes were assessed at baseline using food frequency questionnaire data. Drinking water source at home was obtained in a 1989 follow-up survey. Nitrate-nitrogen (NO_3-N) and total trihalomethane (TTHM) levels for Iowa public water utilities were linked to residences and average levels were computed based on each woman's duration at the residence. We computed multivariable-adjusted hazard ratios (HR) and 95% confidence intervals (CI) using Cox proportional hazards regression. We tested interactions of nitrate with TTHMs and dietary factors known to influence NOC formation. Ovarian cancer risk was 2.03 times higher (CI = 1.22–3.38, $p_{trend} = 0.003$) in the highest quartile ($\geq$2.98 mg/L) compared with the lowest quartile ($\leq$0.47 mg/L; reference) of NO_3-N in public water, regardless of TTHM levels. Risk among private well users was also elevated (HR = 1.53, CI = 0.93–2.54) compared with the same reference group. Associations were stronger when vitamin C intake was <median ($p_{interaction} = 0.01$ and 0.33 for private well and public supplies, respectively). Dietary nitrate was inversely associated with ovarian cancer risk ($p_{trend} = 0.02$); whereas, dietary nitrite from processed meats was positively associated with the risk ($p_{trend} = 0.04$). Our findings indicate that high nitrate levels in public drinking water and private well use may increase ovarian cancer risk among postmenopausal women.

Ovarian cancer has the highest mortality rate among all cancers of the female reproductive system.[1] Given its poor prognosis, identifying risk factors is critical to decrease mortality from ovarian cancer. However, the etiology of this malignancy is poorly understood. A large variation in ovarian cancer incidence among countries[2] and the increased risk of ovarian cancer among immigrants to the United States from other countries with low ovarian cancer incidence such as Japan[3,4] suggest a role of environmental factors, including diet. However, few modifiable risk factors have been identified to date.

Nitrate is a common contaminant of drinking water. Nitrogen from nitrogen fertilizer applications and animal and

Key words: nitrate, nitrite, ovarian cancer, diet, drinking water, disinfection byproducts
Abbreviations: BMI: body mass index; CI: confidence interval; CSFII: Continuing Survey of Food Intake by Individuals; DBP: disinfection byproduct; FFQ: food frequency questionnaire; HAA: haloacetic acid; HR: hazard ratio; IWHS: Iowa Women's Health Study; MCL: maximum contaminant level; NOC: *N*-nitroso compounds; RDI: recommended daily intake; TTHM: total trihalomethane.
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What's new?
While environmental factors such as diet are thought to have a role in ovarian cancer, few such factors have been identified. In the present study, the ingestion of nitrate and nitrite was investigated for possible involvement in ovarian cancer. Among postmenopausal women, risk of ovarian cancer was found to be positively associated with elevated nitrate levels in public drinking water supplies and with nitrite intake from processed meats. Elevated nitrate levels in private well water was linked to increased ovarian cancer risk among women with reduced vitamin C intake.

human waste can contaminate surface and groundwater drinking water sources. The maximum contaminant level (MCL) for public water supplies in the United States is 10 mg/L nitrate-nitrogen (NO_3-N) and is based on preventing methemoglobinemia or blue-baby syndrome in infants.[5] However, the long-term effects of chronic intake of moderately high levels (*i.e.*, $\geq$5 mg/L) of nitrate from drinking water on cancer risk are still not clear.[6,7] Nitrate is also a natural component of plants and is found at high levels in certain vegetables.[7] Nitrate and nitrite salts are also added as preservatives to processed meats such as bacons and hot dogs to prevent bacterial growth and to add color and flavor.[7]

About 5% of ingested nitrate is endogenously reduced to nitrite by bacteria in the oral cavity.[7] Under the acidic conditions in the stomach, nitrite is converted to nitrous acid, which can then be converted to nitrosating agents. Once formed, nitrosating agents can react with amines and amides to form nitrosamines and nitrosamides (collectively called *N*-nitroso compounds [NOCs]). Most NOCs are potent animal carcinogens[8] and ingested nitrate and nitrite are considered probable human carcinogens (2A) under conditions that result in endogenous nitrosation.[7] Nitrosamides directly alkylate DNA and may induce tumors in many organs, whereas nitrosamines must be activated by specific cytochrome P450 enzymes to be carcinogenic.[7] The organ specificity of tumor induction may therefore stem from tissue-specific cytochrome P450 enzymes, which vary in level across organs and species. Cytochrome P450 enzymes have been found in ovarian epithelial tissue of animals.[9,10] Certain nutrients are known to influence endogenous NOC formation in the stomach. Antioxidants, especially vitamin C, reduce the endogenous NOC formation in humans.[7] In contrast, heme iron, which is found mostly in red meats, has been shown to enhance total NOC formation.[11] However, epidemiologic evidence of such interactions on cancer risk is still evolving.

The Iowa Women's Health Study (IWHS) is a large ongoing prospective cohort study started in 1986. In prior analyses, we observed an increased risk of ovarian cancer among women who reported drinking public water with elevated nitrate levels; however, the association was not statistically significant based on a relatively small number of cases ($n = 82$).[12] With an additional 12 years of follow-up, we evaluated whether nitrate and nitrite intake from diet and drinking water (public supplies and private wells) were associated with ovarian cancer risk. We further evaluated whether the association between nitrate and nitrite intake and ovarian cancer risk was modified by dietary factors that may inhibit (vitamin C and E) or enhance (red meats) endogenous NOC formation and by levels of disinfection byproducts (DBPs) in drinking water.

Materials and Methods

The Iowa Women's Health Study (IWHS)

The study design of the IWHS has been described in detail.[13] In brief, a self-administered questionnaire was mailed to 99,826 women, aged 55–69 years, randomly selected from the Iowa State's driver's license list in 1986. Of these women, 41,836 (42%) completed the baseline questionnaire assessing a study participant's demographics, anthropometry, lifestyle, familial history of cancer, medical and reproductive histories, and dietary intake. Respondents and non-respondents were comparable in terms of baseline characteristics.[14] Five follow-up questionnaires (1987, 1989, 1992, 1998 and 2004) have been administered *via* mail. The IWHS was approved by the Institutional Review Boards of the University of Minnesota and the University of Iowa. Return of the completed questionnaire was considered as a subject's consent to study participation.

Dietary intake assessment

Dietary intake at baseline was assessed using the Harvard food frequency questionnaire (FFQ). Study participants were asked their usual intake frequency of 126 food items and the use of dietary supplements over the previous 12 months. The FFQ has been shown to have good validity and reproducibility for major macro- and micronutrients in the IWHS.[15] Nutrient intakes were computed by multiplying the frequency of consumption of each food by the nutrient content. Total intakes of vitamin C and E were calculated by combining intake from foods and dietary supplements.

The nitrate and nitrite contents of foods were determined from a literature review focusing on published reports for U.S. or Canadian populations as previously described.[16,17] We computed means of nitrate and nitrite values for foods weighted by the number of samples and accounting for preparation (raw, cooked and canned) when possible. Nitrate and nitrite contents of FFQ line items were computed by weighting the food-specific values by sex-specific intake amounts from the 1994–1996 Continuing Survey of Food Intake by Individuals (CSFII).[18] For each study participant, we computed nitrate and nitrite intake overall and from plant and animal sources separately, including from processed meats only.

Water nitrate and DBP estimation

Information on drinking water was collected in a follow-up questionnaire mailed in 1989. Participants were asked the main source of drinking water at their current residence (municipal water system, rural water system, bottled water, private well water, other) and how long they had been drinking water from the indicated water source (<1, 1–5, 6–10, 11–20, >20 years). Of the 36,127 women completing the questionnaire (89% response rate), 27,409 (78%) reported public (municipal or rural) water and 6,634 (19%) reported private well water. Of the 27,409 women reporting public water, 22,375 (82%) reported using their water source for ≥11 years and 19,282 (70%) used it for >20 years. Of the 6,634 private well water drinkers, 5,862 (88%) used their water source for ≥11 years and 4,953 (75%) used it for >20 years. Information on tap water consumption at home and work was not collected.

We estimated nitrate and DBP levels in drinking water supplies using an historical municipal water supply monitoring database for Iowa. The database included NO_3-N measurements from finished water samples (1955–1988). NO_3-N levels in water samples were analyzed at the University of Iowa Hygienic Laboratory using standard methods.[19,20] Total trihalomethanes (TTHMs) and the sum of five haloacetic acids (HAA5) are the regulated DBPs.[21] TTHMs are the sum of four trihalomethanes (chloroform, bromoform, bromodichloromethane and dibromochloromethane). HAA5 is the sum of monochloro-, dichloro-, trichloro-, monobromo- and dibromoacetic acids.

A detailed description of the exposure assessment of DBPs in drinking water, developed in the context of another study, may be found elsewhere.[22] Routine monitoring of TTHMs started in the mid-1980s, and HAA5 in the mid-1990s. Annual average estimates for each DBP before these time periods were based on expert assessments, which considered measured TTHMs and HAA5 concentrations available in databases and historical information on water source, disinfection (pre-, intermediate and/or post-treatment; use of chlorine and/or chloramines) and other water treatment practices (*e.g.*, filtration, coagulation, sedimentation, softening), as well as selected water quality parameters.[22,23] Of the 356 Iowa public water utilities that served ≥ 1,000 persons at the time of estimation, we selected 34 that represented six categories of source water (surface water, shallow groundwater with high levels of brominated THMs, shallow groundwater with low levels of brominated THMs, nonalluvial groundwater with high levels of brominated THMs, nonalluvial groundwater with low levels of brominated THMs, and mixed surface/groundwater systems). We estimated DBP levels for these 34 utilities, considering measured data, changes in source water and/or treatment/disinfection practices over time, and water quality data. Whenever a utility significantly changed its historical treatment/disinfection process or source water, new DBP estimates were made. These annual estimates of 34 representative utilities were assigned to other utilities that used the same water source and similar water treatment and disinfection scheme.

Our study participants included in the water contaminant analyses lived in a total of 473 cities. We estimated the median duration of reported drinking water source categories (1–5, 6–10, 11–20, >20 years) as 4, 8, 16 and 40 years, respectively, based on complete water source history data from female controls of comparable ages in population-based case–control studies conducted during the same time period in Iowa.[24] For each median duration, we computed the means for NO_3-N and DBPs and the number of years in the time period for which the annual estimates exceeded half the MCL (5 mg/L and 40 μg/L for NO_3-N and TTHMs, respectively). In the previous analysis,[12] average NO_3-N levels (1955–1988) were assigned to each participant regardless of duration at their water source. In this study, we assigned average NO_3-N levels depending on their residential cities as well as the duration of using the reported water source. The NO_3-N estimates for each woman in the current study were highly correlated with our previous estimates (Spearman correlation coefficient, $r = 0.94$).

Statistical analysis

We excluded women who met the following criteria at baseline (numbers of subjects are not exclusive): (1) previous cancer diagnosis ($n = 3,830$); (2) premenopausal at baseline ($n = 569$); (3) history of bilateral oophorectomy ($n = 8,064$); and (4) an incomplete FFQ (left ≥ 30 items blank) or implausible energy intake (<600 or >5,000 kcal/day) ($n = 3,102$). In addition, we excluded ovarian cancers other than common epithelial cancers, including cancers of germ cell, sex-cord-stromal and others ($n = 27$), resulting in 28,555 women in the analysis for dietary nitrate and nitrite. We further limited drinking water analyses to women who provided drinking water information and reported using their water source for ≥11 years. In addition, we excluded women who lived in cities with public water systems that derived <75% from the same water source. The latter exclusion should increase the validity of the exposure measurement, as contaminant levels can vary between surface and groundwater sources as well as by depth of groundwater sources.[12] As a result, 17,216 women (13,051 drinking public water and 4,164 drinking private well water) remained in the drinking water analyses.

Incident common epithelial ovarian cancers (1986–2010) were identified *via* the annual linkage with the State Health Registry of Iowa's cancer registry, which is part of the Surveillance, Epidemiology and End Results program of the National Cancer Institute. Diagnosis date, type, stage and morphology of each incident cancer were obtained. Vital status (the date and cause of death) is annually identified through the linkage with the State Health Registry of Iowa, supplemented with the National Death Index. Person-years were computed from the date of return of the baseline questionnaire to the date of first ovarian cancer diagnosis, bilateral oophorectomy (self-reported), emigration from Iowa (<0.5% annually), death or December 31, 2010, whichever came first.

Pair-wise correlations among NO_3-N and eight DBPs were evaluated using Spearman correlation coefficients (*r*). The eight DBPs were highly correlated ($r = 0.67$–0.98; Supporting Information Table S1) and we used TTHMs, the sum of the most prevalent DBP class measured, as a surrogate for total halogenated DBPs. Categorical variables were generated for water NO_3-N and TTHM levels (quartiles) and dietary nitrate and nitrite intake (quintiles). Because the range of nitrite intake from processed meats was narrow, we created a 4-level categorical variable (0, >0–0.09, 0.1–0.19, ≥0.2 mg/d) based on its distribution. We compared selected baseline characteristics by NO_3-N levels in public water and private well water use. Hazard ratios (HR) and 95% confidence intervals (CI) were computed using Cox proportional hazards regression as the measure of association with the lowest level as a reference group. We selected *a priori* several baseline characteristics that are risk or protective factors for ovarian cancer as covariates in the multivariable-adjusted model. These covariates included age (continuous), body mass index (BMI, continuous), familial history of ovarian cancer, number of live births (nulliparous, 1–2, 3–4, ≥5), age at menarche (≤ or >12), age at menopause (<45, 45–49, 50–54, ≥55), age at first live birth (<20, 20–24, 25–29, ≥30), oral contraceptive use (never, ever), estrogen use (never, ever) and history of unilateral oophorectomy. In the drinking water analyses, we mutually adjusted for NO_3-N and TTHMs levels (continuous) to evaluate the independent effect of each contaminant. Dietary nitrate and nitrite analyses were additionally adjusted for total energy intake and dietary factors (continuous) that were associated with ovarian cancer risk and were moderately correlated with dietary nitrate or nitrite intake in our study population (cruciferous vegetables, $r = 0.53$ and red meat, $r = 0.48$). Logarithmically transformed values were used for NO_3-N and TTHM levels and dietary factors as covariates, as their distributions were markedly skewed. We tested trends for associations across exposure levels using the median in each category as continuous variables. Because NO_3-N measurements in private well water were not available, ovarian cancer risk among private well water drinkers was compared with the risk among women in the lowest quartile of nitrate in public water. We tested interactions between water NO_3-N and TTHM levels as well as between nitrate (from drinking water or diet) and total vitamin C, E and red meat intake by stratified analyses (≤ or > median) and by including interaction terms (*i.e.*, cross products of dichotomous variables for vitamin C, E and red meats and median in nitrate or nitrite quartile or quintile as continuous variables) in regression models. We performed sensitivity analyses limited to women who reported using the same water source for >20 years. Statistical significance for all analyses was defined as $p < 0.05$.

Results

Mean age of study participants at baseline was 61.6 years (standard deviation, SD = 4.2 years). During the follow-up, 315 incident common epithelial ovarian cancers were identified. Of these, 190 ovarian cancers were included in water nitrate analysis (145 using public water supplies and 45 using private wells). Mean (SD) age at diagnosis was 73.2 (7.7) years. Higher risk for ovarian cancer was observed among women with a familial history of ovarian cancer, no history of unilateral oophorectomy, who were nulliparous and had fewer live births. Oral contraceptive use and ages at menarche and menopause were not associated with ovarian cancer risk; nor were demographic and lifestyle factors such as farm residence, age, BMI, cigarette smoking, physical activity, or alcohol intake. Median NO_3-N and TTHM levels for women drinking from public water supplies were 1.08 mg/L (range: 0.01–25.34 mg/L) and 4.59 μg/L (range: 0–200.88 μg/L), respectively. NO_3-N levels were not correlated with TTHMs or other DBP estimates ($r = -0.03$-0.29) (Supporting Information Table S1). A history of unilateral oophorectomy was slightly more prevalent among women with elevated NO_3-N levels in public water (Table 1). Other factors and dietary intake were not different across NO_3-N levels in public water. More than 90% of women who reported drinking private well water lived on a farm (72%) or in non-farm rural areas (19%) while about 95% of public water drinkers lived in towns. Compared with public water drinkers, more women on private well water had lower education levels, never smoked, had no history of unilateral oophorectomy and never used estrogens or oral contraceptives. Intakes of total calories and red meats (energy-adjusted) were higher among private well water drinkers than public water drinkers. In contrast, total vitamin C intake and energy-adjusted intakes of dietary nitrate and fruits and vegetables were slightly lower among private well users than public water drinkers.

Women who consumed water containing elevated NO_3-N levels were at higher risk for ovarian cancer ($HR_{Q4\ vs.Q1} = 2.14$, CI = 1.30–3.54, $p_{trend} = 0.002$; Table 2). This association did not change substantially by adjusting for TTHM levels. Longer duration of exposure to NO_3-N at levels exceeding half the MCL (5 mg/L) was associated with higher risk for ovarian cancer ($p_{trend} = 0.02$). Women who had ingested water with NO_3-N exceeding 5 mg/L for ≥4 years were at 1.6 times higher risk for ovarian cancer compared with women with no exposure to NO_3-N exceeding 5 mg/L (CI = 1.06–2.41). In contrast, neither average TTHM levels in public water nor years of exposure to TTHM levels exceeding half the MCL (40 μg/L) were associated with ovarian cancer risk. When stratified by low or high TTHM levels (≤ or >median, 4.60 μg/L), there was no evidence of interaction of NO_3-N with TTHMs (data not shown). None of the individual DBPs was associated with ovarian cancer risk (Supporting Information Table S2). Although not statistically significant, ovarian cancer risk was higher among private well users compared with those with the lowest NO_3-N levels in public water (HR = 1.53, CI = 0.93–2.54). Similar

Table 1. Demographic, lifestyle, reproductive and dietary factors among 17,216 women and by mean nitrate levels in public water and private well water use

		Mean nitrate (mg/L nitrate–nitrogen) levels in public water				Private well water
	All	0.01–0.472	0.473–1.08	1.09–2.97	2.98–25.34	
N	17,216	3,263	3,269	3,504	3,015	4,165
Age, years (mean ± SD)	61.6 ± 4.2	61.8 ± 4.2	61.7 ± 4.2	61.7 ± 4.2	61.7 ± 4.2	61.2 ± 4.1
BMI, kg/m^2 (mean ± SD)	26.9 ± 5.0	26.8 ± 5.0	26.7 ± 4.9	26.6 ± 5.0	26.8 ± 5.0	27.4 ± 5.1
Education, ≥ high school (%)	83.8	83.7	84.3	83.5	86.1	81.8
Residence location (%)						
Farm	19.6	3.3	3.3	2.1	2.5	71.9
Rural area (not farm)	6.2	1.7	2.3	1.4	3.0	19.1
Town	74.2	95.0	94.4	96.5	94.5	9.0
Smoking, ever (%)	34.3	37.2	38.9	40.3	37.2	21.3
Physical activity, low (%)	47.3	46.6	47.0	47.8	47.1	47.8
Unilateral oophorectomy (%)	9.8	11.3	10.2	9.8	9.7	8.7
Estrogen use, ever (%)	31.8	33.3	32.4	33.6	33.3	27.6
Oral contraceptive use (%)	19.8	20.7	21.0	19.5	19.0	19.1
Age at menarche ≥ 13 years (%)	57.4	58.4	57.4	56.7	56.6	58.0
Age at menopause ≥ 50 years (%)	53.8	51.9	53.2	52.5	53.0	57.3
Number of live births (mean ± SD)	3.1 ± 1.9	3.1 ± 2.0	3.0 ± 1.9	2.9 ± 1.8	2.9 ± 1.8	3.5 ± 2.0
Age at first live births, years (mean ± SD)	21.0 ± 7.7	20.7 ± 8.0	20.8 ± 7.8	20.7 ± 8.1	21.0 ± 7.8	21.5 ± 6.8
Total calorie intake, kcal (median)	1,731	1,699	1,693	1,702	1,694	1,839
Total vitamin C intake, mg/d (median)	188	189	189	188	192	186
Total vitamin E intake, mg/d (median)	9.5	9.5	9.5	9.5	9.5	9.5
Energy-adjusted intake[1] (median)						
Nitrate, mg/d	60.8	61.0	61.1	61.7	61.5	59.2
Fruits and vegetables, servings/wk	23.6	23.5	23.9	23.9	23.8	23.0
Red meat, servings/wk	3.0	2.9	1.9	2.9	2.8	3.5
Processed meat, servings/wk	0.7	0.7	0.7	0.7	0.7	0.7

[1]Intake adjusted for 1,000 kcal/d of total energy intake.

elevated risks were observed among private well drinkers who lived on a farm (HR = 1.49, CI = 0.87–2.55) or in rural areas or towns (HR = 1.64, 95% CI = 0.83–3.24). These associations remained unchanged after adjusting for dietary nitrate and nitrite intake. When limiting analyses to women who reported using the same water source for >20 years, all observed associations became slightly stronger.

The association between higher nitrate levels in public water and ovarian cancer was stronger among women with low vitamin C intake (≤ median, 190 mg/d, $p_{\text{trend}} = 0.005$) compared with those with high intake (> median, $p_{\text{trend}} = 0.12$); however, the interaction was not statistically significant ($p_{\text{interaction}} = 0.33$, Table 3). The elevated risk among private well water drinkers was observed only among women with low vitamin C intake (HR = 3.30, CI = 1.44–7.56, $p_{\text{interaction}} = 0.01$). We also attempted to use different cutpoints for total vitamin C intake including the recommended daily intake (RDI) for non-smoking adult women (=70 mg/d) and the first quartile of total vitamin C intake in our study population (=125 mg/d). Similar stronger positive associations between water nitrate and ovarian cancer risk were observed among women with lower vitamin C intake (data not shown); however, CIs in the low vitamin C intake group were wide due to small numbers of ovarian cancer cases. A stronger association between NO_3-N levels in public water or private well use and ovarian cancer risk was observed among women with high *vs.* low red meat intake although the interaction was not statistically significant.

Mean (SD) dietary nitrate and nitrite intakes were 123.3 mg/d (83.4 mg/d) and 1.2 mg/d (0.5 mg/d), respectively. Total dietary nitrate intake and nitrate intake from plants (*e.g.*, high nitrate vegetables such as lettuce, celery, beets, spinach and broccoli) were highly correlated ($r = 0.99$). On average, about 38% of dietary nitrite intake came from

Table 2. Exposures to nitrate–nitrogen (NO_3–N) and total trihalomethanes (TTHMs) in public water and ovarian cancer risk

	Median	*N*	Cases	HR (95% CI)		
				Age-adjusted	Model 1[1]	Model 2[2]
NO_3-N (mg/L)						
0.01–0.472	0.31	3,263	23	1.0	1.0	1.0
0.473–1.08	0.75	3,269	32	1.41 (0.82–2.41)	1.36 (0.80–2.34)	1.27 (0.73–2.21)
1.09–2.97	1.68	3,504	41	1.66 (1.00–2.76)	1.55 (0.92–2.59)	1.45 (0.85–2.44)
2.98–25.34	3.81	3,015	49	2.34 (1.42–3.84)	2.14 (1.30–3.54)	2.03 (1.22–3.38)
p_{trend}				0.0005	0.002	0.003
Private well water	–	4,165	45	1.50 (0.91––2.49)	1.53 (0.93–2.54)	–
Years of NO_3-N >5 mg/L[3]						
0	0	9,206	91	1.0	1.0	1.0
1–3	1	1,871	22	1.20 (0.75–1.91)	1.05 (0.64–1.72)	1.08 (0.65–1.77)
≥ 4[4]	8	1,974	32	1.66 (1.11–2.49)	1.60 (1.06–2.41)	1.52 (1.00–2.31)
p_{trend}				0.01	0.02	0.05
TTHMs (μg/L)						
0–0.89	0.47	3,112	27	1.0	1.0	1.0
0.90–4.59	1.95	3,612	33	1.07 (0.64–1.78)	1.10 (0.65–1.86)	1.08 (0.64–1.82)
4.77–14.31	10.67	3,524	55	1.82 (1.15–2.89)	1.86 (1.146– 3.00)	1.64 (1.00–2.70)
14.50–200.88	76.32	2,803	30	1.27 (0.76–2.14)	1.31 (0.77–2.24)	1.24 (0.73–2.13)
p_{trend}				0.78	0.74	0.80
Years of TTHMs >40 μg/L[3]						
0	0	9,838	110	1.0	1.0	1.0
> 0–35	3	1,442	17	1.05 (0.63–1.76)	1.00 (0.59–1.70)	0.99 (0.59–1.68)
≥ 36[4]	40	1,771	18	0.93 (0.56–1.53)	0.90 (0.54–1.50)	0.91 (0.55–1.52)
p_{trend}				0.84	0.69	0.72

[1]Adjusted for age, BMI, family history of ovarian cancer, number of live births (0, 1–2, 3–4, ≥ 5), age at menarche ($\leq$ or >12), age at menopause (< 45, 45–49, 50–54, ≥ 55), age at first live birth (< 20, 20–24, 25–29, ≥ 30), oral contraceptive use (never, ever), estrogen use (never, ever) and history of unilateral oophorectomy.
[2]Additionally mutually adjusted for logarithmically transformed values of NO_3–N or TTHMs levels in public water.
[3]Half the maximum contaminant level (MCL) determined by the U.S. Environmental Protection Agency.
[4]The median years of exposures to a half of MCL among women who exposed during the reported duration of exposure.

animal sources and 15% came from processed meats. Higher dietary nitrate intake was observed among IWHS participants reporting higher age, BMI, education level, alcohol intake, physical activity level and estrogen use.[25] Women reporting higher dietary nitrate intake also reported higher intake of total calories, cruciferous vegetables, red meats and vitamins C and E. Higher dietary nitrate intake was associated with lower ovarian cancer risk ($HR_{Q5\ vs. Q1} = 0.61$, CI = 0.40–0.95; $p_{\text{trend}} = 0.02$, Table 4). Dietary nitrite intake was not associated with ovarian cancer risk. Similarly, neither dietary nitrite intake from plant nor animal sources was associated with ovarian cancer risk. However, higher nitrite intake from processed meats was marginally associated with higher ovarian cancer risk after adjusting for confounders ($p_{\text{trend}} = 0.04$). On a continuous scale, the risk was 12% (CI = 4–20%) higher with each 0.1 mg increment in nitrite intake from processed meats. These associations did not change by additional adjustment for total vitamin C and E intakes. There was no interaction between dietary nitrate or nitrite intake and total vitamin C, E or red meat intakes.

Discussion

We found higher risk for epithelial ovarian cancer among women drinking water from public supplies with higher nitrate levels, regardless of TTHM levels. Ovarian cancer risk also appeared higher among women drinking private well water compared with the lowest NO-N_3 quartile in public water supplies, and we observed a statistically significant interaction with vitamin C intake. Higher dietary nitrate intake was associated with lower risk for ovarian cancer, whereas higher nitrite intake from processed meats was associated with higher risk.

Epidemiologic studies of dietary nitrate intake have predominantly evaluated stomach cancer and many studies reported null associations or inverse trends.[7,26] One explanation for these findings is the potential interaction between

Table 3. Ovarian cancer risk in relation to nitrate–nitrogen (NO_3-N) levels in drinking water stratified by high or low total vitamin C and red meat intakes

	Vitamin C ≤190 mg/d				Vitamin C >190 mg/d				
	N	Cases	HR (95% CI)[1]	p_{trend}	*N*	Cases	HR (95% CI)[1]	p_{trend}	$p_{interaction}$
NO_3-N (mg/L)									
0.01–0.472	1,625	7	1.0	0.005	1,638	16	1.0	0.12	0.33
0.473–1.08	1,629	14	1.85 (0.74–4.65)		1,640	18	1.16 (0.59–2.29)		
1.09–2.97	1,762	26	3.17 (1.37–7.32)		1,742	15	0.83 (0.40–1.70)		
2.98–25.34	1,467	24	3.39 (1.45–7.95)		1,548	25	1.60 (0.85–3.02)		
Private well water[2]	2,125	29	3.30 (1.44–7.56)	–	2,040	16	0.77 (0.38–1.54)	–	0.01
	Red meats ≤5 servings/wk				Red meats >5 servings/wk				
	N	Cases	HR (95% CI)[1]	p_{trend}	*N*	Cases	HR (95% CI)[1]	p_{trend}	$p_{interaction}$
NO_3-N (mg/L)									
0.01–0.472	1,812	13	1.0	0.18	1,451	10	1.0	0.002	0.14
0.473–1.08	1,853	21	1.61 (0.81–3.22)		1,416	11	1.04 (0.43–2.50)		
1.09–2.97	2,032	26	1.69 (0.86–3.30)		1,472	15	1.36 (0.60–3.06)		
2.98–25.34	1,788	25	1.82 (0.93–3.57)		1,227	24	2.59 (1.23–5.48)		
Private well water[2]	1,629	15	1.34 (0.64–2.82)	–	2,536	30	1.68 (0.82–3.44)	–	0.63

[1]Adjusted for age, BMI, family history of ovarian cancer, number of live births (0, 1–2, 3–4, ≥5), age at menarche (≤ or >12), age at menopause (< 45, 45–49, 50–54, ≥55), age at first live birth (< 20, 20–24, 25–29, ≥30), oral contraceptive use (never, ever), estrogen use (never, ever) and a history of unilateral oophorectomy.
[2]HR and 95% CI were computed with the lowest quartile of nitrate among public water drinkers as a reference group.

nitrate and antioxidants, which are abundant in major dietary sources of nitrate such as green leafy and root vegetables.[27,28] Antioxidants, such as vitamins C and E, inhibit NOC formation by reducing nitrite to nitric oxides, and thus decreasing the level of NOCs and NOC-induced DNA adducts.[29,30] Therefore, a potentially carcinogenic effect of dietary nitrate intake may be reduced or eliminated by the protective effects of high antioxidant intake from fruits and vegetables. Indeed, dietary nitrate intake was highly correlated with total vegetable intake ($r = 0.84$), and moderately correlated with antioxidant intakes ($r = 0.36$–0.46) in our study.

Carcinogenic effects of NOCs in the ovary have been shown in animal studies.[9,10] However, to date, NOCs and their precursors nitrate and nitrite have been evaluated in relation to ovarian cancer risk in only a few epidemiologic studies. Ovarian cancer risk was evaluated in relation to dietary nitrate intake in two prospective cohort studies and these studies found no associations.[12,31] Dietary nitrite intake and ovarian cancer was assessed in only one prior cohort study.[31] In that study, total nitrite intake and nitrite intake from plant sources were not associated with epithelial ovarian cancer risk, but higher nitrite intake from animal sources was associated with higher risk ($HR_{Q5\ vs.\ Q1} = 1.34$, CI = 1.05–1.69, $p_{trend} = 0.02$). Processed meats contain added nitrate and nitrite as well as high amounts of amines and amides, precursors of NOCs. Ingestion of nitrate in combination with nitrosatable precursors has been shown to increase the formation of NOCs.[32] Furthermore, red and processed meats contain heme iron, a component of myoglobin, which promotes the formation of NOCs.[11] Therefore, nitrate and nitrite added to processed meats may result in exogenous and endogenous NOC formation. Three large prospective cohort studies have found statistically non-significant trends towards positive associations between processed meat intake and ovarian cancer.[33–35] Meta-analysis of four prospective cohort studies found a borderline positive exposure response between processed meat intake and ovarian cancer risk (HR = 1.05, CI = 0.98–1.14 for an intake increment of 100 g per week).[36]

Unlike dietary nitrate, nitrate from drinking water is not accompanied by micronutrients that could inhibit endogenous nitrosation. Therefore, nitrate from drinking water could result in more endogenously formed NOCs than nitrate from foods. Previous epidemiologic studies, including our study,[12] have shown associations between nitrate levels in public water and the risk of cancer, including bladder,[12] stomach and colorectal cancers.[6,7] However, ovarian cancer has been assessed in relation to nitrate in public water only in our previous analysis in the IWHS, as one of multiple cancer outcomes.[12] In our previous analysis including 82 incident ovarian cancers, we observed a positive association between higher nitrate levels in public water supplies and the risk of ovarian cancer ($HR_{Q4\ vs.\ Q1} = 1.86$, CI = 0.82–4.26); however, this association did not reach statistical significance level. In the current study, we found a statistically significant more than two-fold risk for ovarian cancer among women in the highest (median = 3.81 mg/L) compared in the lowest (median = 0.31 mg/L) NO_3-N quartiles in public water supplies.

Epidemiology

Table 4. Dietary nitrate and nitrite intake and ovarian cancer risk among 28,555 women

	Median	*N*	Cases	HR (95% CI) Model 1[1]	HR (95% CI) Model 2[2]
Nitrate (mg/d)					
Total intake					
Q1: 3.87–65.43	49.5	5,711	59	1.0	1.0
Q2: 65.44–92.04	78.9	5,711	73	1.18 (0.83–1.68)	1.05 (0.73–1.50)
Q3: 92.05–121.96	106.2	5,711	54	0.86 (0.58–1.26)	0.72 (0.48–1.06)
Q4: 121.97–165.48	140.2	5,711	74	1.21 (0.84–1.74)	0.96 (0.66–1.41)
Q5: 165.54–2,083.52	209.2	5,711	55	0.85 (0.56–1.27)	0.61 (0.40–0.95)
p_{trend}				0.37	0.02
Per 10 mg/d	–	–	–	0.99 (0.98–1.01)	0.98 (0.96–1.00)
Nitrite (mg/d)					
Total intake					
Q1: 0.11–0.80	0.7	5,709	62	1.0	1.0
Q2: 0.81–1.02	0.9	5,716	52	0.84 (0.56–1.26)	0.80 (0.53–1.21)
Q3: 1.021–1.23	1.1	5,716	65	1.12 (0.73–1.72)	1.04 (0.68–1.59)
Q4: 1.239–1.53	1.4	5,703	70	1.26 (0.79–2.02)	1.14 (0.71–1.82)
Q5: 1.537–7.13	1.8	5,711	66	1.20 (0.68–2.12)	1.03 (0.58–1.84)
p_{trend}				0.24	0.50
Per 0.1 mg/d	–	–	–	1.00 (0.97–1.04)	0.99 (0.95–1.03)
Animal sources					
Q1: 0–0.26	0.2	5,638	63	1.0	1.0
Q2: 0.26–0.36	0.3	5,689	44	0.68 (0.45–1.02)	0.72 (0.48–1.08)
Q3: 0.36–0.47	0.4	5,597	83	1.29 (0.89–1.88)	1.39 (0.96–2.02)
Q4: 0.47–0.61	0.5	5,668	59	0.89 (0.59–1.37)	0.98 (0.64–1.50)
Q5: 0.61–3.47	0.7	5,648	66	1.04 (0.64–1.67)	1.18 (0.72–1.91)
p_{trend}				0.45	0.25
Per 0.1 mg/d	–	–	–	1.04 (0.98–1.11)	1.06 (1.00–1.13)
Processed meats					
0	0	4,872	54	1.0	1.0
$>$ 0–0.09	0.04	19,770	212	0.94 (0.69–1.28)	1.01 (0.74–1.38)
0.1 – 0.19	0.13	2,537	32	1.15 (0.73–1.82)	1.27 (0.80–2.01)
$\geq$ 0.2	0.26	1,135	17	1.46 (0.82–2.58)	1.65 (0.93–2.94)
p_{trend}				0.10	0.04
Per 0.1 mg/d	–	–	–	1.10 (1.03–1.19)	1.12 (1.04–1.20)
Plant sources					
Q1: 0.04–0.47	0.4	5,701	64	1.0	1.0
Q2: 0.47–0.61	0.5	5,717	62	0.88 (0.61–1.28)	0.82 (0.56–1.19)
Q3: 0.61–0.76	0.7	5,712	57	0.87 (0.59–1.28)	0.77 (0.52–1.14)
Q4: 0.76–0.98	0.9	5,721	67	1.01 (0.67–1.51)	0.86 (0.57–1.29)
Q5: 0.98–6.39	1.2	5,704	65	0.96 (0.60–1.52)	0.77 (0.48–1.24)
p_{trend}				0.79	0.54
Per 0.1 mg/d	–	–	–	0.99 (0.95–1.03)	0.97 (0.92–1.01)

[1]Adjusted for age, BMI, family history of ovarian cancer, number of live births (0, 1–2, 3–4, ≥ 5), age at menarche ($\leq$ or >12), age at menopause (< 45, 45–49, 50–54, ≥ 55), age at first live birth (< 20, 20–24, 25–29, ≥ 30), oral contraceptive use (never, ever), estrogen use (never, ever), history of unilateral oophorectomy and total energy intake (logarithmically transformed).
[2]Additionally adjusted for logarithmically transformed values of cruciferous vegetable and red meat intake.

For the first time, we found evidence suggesting a higher risk for ovarian cancer among women who were private well water drinkers. In Iowa, agricultural application of nitrogen is the major source of environmental nitrate contamination. Nitrate levels can be high in private wells in agricultural areas because of their location close to crop fields treated with nitrogen fertilizer and livestock manure, and because private wells are not regulated and may not be routinely monitored. In the United States, the average NO_3-N levels in streams and groundwater in agricultural areas are over 3 mg/L whereas average levels in urban areas and areas with mixed land use are about 1.5 mg/L and 1 mg/L, respectively.[6] About 22% of private wells in agricultural areas in the United States exceed the nitrate MCL (10 mg/L NO_3-N).[6] A survey of rural private wells in Iowa in 1988–1989 found that 18% of wells exceeded the MCL for nitrate. In addition, 37% of these rural private wells had levels greater than 3 mg/L, typically considered indicative of anthropogenic pollution.[37] We observed similarly elevated risk of ovarian cancers among private well users in farm and non-farm areas. Most of Iowa land is used for agriculture with row crops and grasslands covering 90% and urban areas accounting for only 1% of the state surface area.[38] Therefore, private wells located in non-farm rural areas or towns are likely to be in close proximity to farms and thus impacted by the agricultural use of nitrogen fertilizers. Nitrate levels in private well water are determined by many factors including geological characteristics and agricultural practices.[37] Well depth is the best predictor of well-water nitrate contamination with higher nitrate levels found in shallower wells. NO_3-N levels in 35% of private wells less than 15 m deep exceeded the MCL (about 28% of private wells in Iowa are less than 15 m deep).[37,39] Unfortunately, information on well depth was not collected in our study.

It should be noted that elevated nitrate levels may be an indicator of contamination with other chemicals or bacteria.[40] In agricultural areas, wells with elevated nitrate levels may also have elevated levels of herbicides, some of which are suspected carcinogens. For example, atrazine, a triazine herbicide, is one the most frequently detected pesticides in Iowa groundwater, and occupational exposure is a hypothesized risk factor for ovarian cancer.[41,42] Exposures to pesticides *via* drinking water are likely to be substantially lower than occupational exposures but few studies have been conducted. Atrazine and its metabolites have been detected in Iowa public water supplies, although levels are usually below the MCL and detections are not as frequent as for nitrate.[43] The 1988–1989 state-wide survey revealed that pesticides were present in about 5% of private wells in Iowa.[37] DBPs in drinking water have been associated with higher risk for bladder cancer and possibly other sites.[44] We evaluated, for the first time, DBPs in drinking water in relation to ovarian cancer and found only non-significant, uneven elevations of risk for the DBP metrics in our analysis. Evaluation in other populations would be valuable.

Ovarian cancer is a relatively rare cancer, but a large sample size as well as a long follow-up period enabled us to study 190 cases in relation to water contaminants. Emigration from Iowa rarely occurred in our cohort (<0.5% annually), enabling a nearly complete follow-up of the cohort and likely detection of most incident ovarian cancers. The attainment of water nitrate and DBP data through a linkage with a historical public water monitoring database is another strength of our study. In addition, reported duration of water source use enabled us to estimate the length of exposure to water contaminants, which is a key factor in exposure assessment. The majority of our cohort participants lived in the same address for more than 10 years at the post-enrollment drinking water data collection, which enabled us to estimate long-term exposures to nitrate and DBPs in drinking water. Our study has limitations as well. Dietary intake was assessed at cohort baseline and may have changed during the long follow-up period. However, dietary intakes assessed at cohort baseline and at the 2004 follow-up survey were reasonably correlated (*e.g.*, $r = 0.44$ for total calorie, 0.39–0.42 for macronutrients, 0.36 for total vegetables and 0.24 for processed meat products) and earlier exposures are likely to be the most relevant for cancer risk. Potential misclassification of dietary intake assessed using a FFQ is also probable. Furthermore, dietary intake assessment by a FFQ cannot capture important information related to the nitrate content and NOC formation such as food storage and cooking methods. Because information on study participants' daily water consumption was not available, patterns in individuals' water consumption such as the amount and timing as well as water consumption outside of their home (*e.g.*, work) was not taken into account in our exposure assessment. In addition, we did not have information on other factors that may influence nitrate metabolism to include in our analyses. For example, factors that affect the number of nitrate-reducing bacteria in saliva, such as mouthwash use and oral hygiene, may alter the rate of nitrate–nitrite conversion by saliva.[7] Similarly, proton-pump inhibitor use increases the pH in the stomach and may increase NOC formation.[45] Finally, study included only postmenopausal white women; therefore, interpretation of our results is limited to this population, and future studies should evaluate these exposures among all women including premenopausal women and other ethnic groups with ovarian cancer.

In conclusion, this study indicates that nitrate from public drinking water may be associated with higher risk of ovarian cancer among postmenopausal women. Our results suggest that postmenopausal women who drink private well water may be at higher risk for ovarian cancer, especially with low vitamin C intake. Our findings also support the hypothesis that dietary nitrite intake from processed meats increases ovarian cancer risk. Additional confirmatory studies with a larger number of ovarian cancer cases are warranted and could result in a novel target for ovarian cancer risk reduction.

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