

FOREWORD

Beneficial Management Practices – Environmental Manual for Feedlot Producers in Alberta

These farm practice guidelines were developed for Alberta feedlot producers through the cooperation of industry, government and interested stakeholders to create greater awareness and understanding of beneficial environmental practices for Alberta feedlots. Information presented in this publication is based on the best available research data and years of experience. The guidelines presented are intended to provide a range of management options for feedlots of various sizes. This document is a living document and will be updated regularly to incorporate new proven technologies and information on environmental practices and regulations. Individuals not experienced in feedlot production practices should not extract portions of this publication, nor draw inference, without considering all aspects of the issue. These guidelines should not be adopted literally into legislation, in whole or in part, by any level of government.

Developed by:

Alberta Cattle Feeders' Association (ACFA)
Alberta Agriculture, Food and Rural Development (AAFRD)

Funded by:

Agriculture Initiatives
Alberta Environmental Sustainable Agriculture (AESAs)
Canadian Adaptation and Rural Development Fund (CARD)
Western Economic Partnership Agreement (WEPA)

Acknowledgements:

Agriculture and Agri-Food Canada, Lethbridge Research Center
Alberta Agriculture, Food and Rural Development (AAFRD)
Alberta Association of Agricultural Fieldmen
Alberta Cattle Feeders' Association (ACFA)
Alberta Environment
Alberta Health and Wellness
Canadian Farm Business Management Council (CFBMC)
Environmental Law Center
Intensive Livestock Working Group (ILWG)
Meristem Information Resources Ltd.
Natural Resources Conservation Board (NRCB)
Prairie Farm Rehabilitation Agency (PFRA)
Texas A and M University (Texas A & M)
The Wilson Law Office
University of Alberta

Disclaimer

The primary purpose of the *Beneficial Management Practices – Environmental Manual for Feedlot Producers in Alberta* is to assist producers with the implementation of management practices that promote environmental sustainability.

It is important to be aware that while the authors have taken every effort to ensure the accuracy and completeness of the *Manual*, the *Manual* should not be considered the final word on the areas of the law and practice that it covers. Producers should seek the advice of appropriate professionals and experts as the facts of each situation may differ from those set out in the *Manual*.

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BENEFICIAL MANAGEMENT PRACTICES – ENVIRONMENTAL MANUAL FOR FEEDLOT PRODUCERS IN ALBERTA

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Unit Conversion Factors

Laboratories report test results using different units. To properly calculate manure or fertilizer application rate, it is crucial to understand the units expressed in the laboratory report.

Abbreviations:

- Phosphorus is elemental P.
- Phosphate is P_2O_5 , which is a fertilizer unit.
- Potassium is elemental K.
- Potash is K_2O , which is a fertilizer unit.
- Nitrogen is N.
- Organic nitrogen is organic N = total N - inorganic N (or ammonium N).
- Total nitrogen is total N = organic N + inorganic N.
- Inorganic N (also called mineral or plant-available N) is ammonium N and nitrate N.
Most of the inorganic N in manure is in ammonium form.

Units:

- 1 kilogram (kg) = 2.205 lb. = 35.28 oz. = 1000 milligrams (mg)
- 1 km = 1000 metres (m) = 3,281 ft. = 39,370 in. = 0.6214 mile
- 1 m³ = 1000 liters (L) = 220 gal. (Imperial) = 264.2 gal. (US)
- 1 hectare (ha) = 10,000 m² = 107,639 ft.² = 2.471 ac.
- 1 kg/ha = 1.12 lb./ac.
- 1 tonne = 1000 kg = 2205 lb. = 1.1025 ton (short)
- 1% = 10 kg/tonne = 10,000 mg/kg = 10,000 parts per million (ppm)
- 1 ppm = 1 mg/kg (solid) or 1 mg/L (liquid)
- 1 lb. (or kg) of P = 2.29 lb. (or kg) of P_2O_5
- 1 lb. (or kg) of K = 1.2 (or kg) lb. of K_2O
- 1 ppm N, P or K (*in 6 inches or 15 cm soil depth*) is approximately equal to 1.8 lb. of N, P or K/ac = 2 kg of N, P or K/ha
- 1 ppm N, P or K (*in 12 inches or 30 cm soil depth*) is approximately equal to 3.6 lb. of N, P or K/ac. = 4 kg of N, P or K/ha

For example: If the lab report shows that P content in soil is 20 ppm in the top 15 cm, this is equivalent to 40 kg P/ha or 36 lb. P/ac.

1.0 INTRODUCTION

1.1 Client and Objective

- The *Beneficial Management Practices – Environmental Manual for Feedlot Producers in Alberta* was prepared for Alberta feedlot producers.
- The objective is to use beneficial management practices, such as a nutrient management plan, to reduce the impact of feedlot production on soil, air and water. As well, the practices outlined in this manual will help reduce nuisance complaints and health effects related to feedlot production. This publication will provide information on the following subject areas:
 - Legal requirements of feedlot operations.
 - Manure storage and handling.
 - Land application (nutrient management).
 - Odour control.
 - Dust control.
 - Site planning and management.
 - Social obligations of feedlot operators.
 - Safe and responsible storage and disposal of agri-chemicals, petroleum products, medical waste and dead animals.
 - Greenhouse gases.

1.1.1 Purpose

The purpose of the *Beneficial Management Practices – Environmental Manual for Feedlot Producers in Alberta* is to document, for producers and society, management options that are environmentally sound, comply with existing regulations and are economically obtainable.

Due to local and regional conditions, not all of these practices herein pertain to any one specific feedlot operation. Rather, one or a combination of these, coupled with other alternatives, may provide optimal results.

With the feedlot industry's commitment to advancing management practices, as demonstrated in the evolution of beef production over the past few decades, this manual will be updated as new standards and technologies are available.

These guidelines describe beneficial management practices designed to protect the environment and minimize nuisance odours, flies and dust.

1.1.2 Use of the guidelines

Feedlot producers may use the information within this document to evaluate and improve their current environmental management practices. When seeking a solution to a particular issue, all aspects of environmentally acceptable farm management should be taken into account. It is not recommended that individuals extract portions of this publication

without considering the entire environmental context of the operation. Individuals who do not possess a strong knowledge of feedlot production should not assess an operation based solely on this publication. This publication is merely one of many resource documents available on feedlot management from industry and government.

1.2 Background

The goal of any farming operation is to be economically viable. This objective is inherently tied to sustainability, and therefore, to being socially and environmentally responsible. When all interested parties understand the operational aspects of beef production and how these practices can affect neighbours, it is easier to gain approval or maintain acceptance for feedlot operations.

In the past 20 years, Alberta's feedlot industry has undergone significant changes, both in size and production methods. Beef production is a specialized industry that is highly integrated with crop production. In many cases, feedlots have become much larger and more capital intensive.

The character of Alberta's rural residential population has also changed. New rural housing represents a major personal investment and owners are sensitive to any activity that may affect enjoyment and/or property value. The result of the changes in the beef industry and in rural residential development has occasionally created conflicts. In today's changing society, people in general are less tolerant to perceived infringements on their rights. This attitude

extends to both rural residents and other agriculture producers. Beef producers must be aware of this attitude shift and consider it in the management of their operations.

Success of the industry locally and in the global marketplace will be determined by how the industry deals with environmental and social issues. The viability of the livestock industry is dependent on the sustainability of the environment; therefore, the protection of the environment is of major concern to the livestock industry.

The Alberta Cattle Feeders' Association, along with its many partners, is leading efforts to maintain and develop an environmentally responsible, sustainable and prosperous feedlot industry. It is continually developing practices, standards and guidelines to assist the feedlot industry to be environmentally sustainable, globally competitive and publicly acceptable. Furthermore, feedlot producers believe that those involved in the production of beef need to use common sense approaches, reasonable management skills appropriate for their operation, and accepted scientific knowledge to avoid detrimental environmental impacts and undue environmental risk.



2.0 ENVIRONMENTAL OBLIGATIONS AND REGULATORY APPROVALS FOR FEEDLOT OPERATORS

Meeting environmental obligations requires an awareness of environmental law. The environmental obligations of a livestock feedlot operator are set out in statutes enacted by the provincial and federal legislatures, and through the common law, which is the body of law and rules established by the courts. The statutes that feedlot operators should be aware of include the *Agricultural Operation Practices Act (AOPA)*, *Alberta Environmental Protection and Enhancement Act*, the *Public Health Act*, the *Livestock Diseases Act*, the *Water Act*, and the federal *Fisheries Act*. Livestock feedlot operators should also be informed of the common law rules of nuisance and how these rules are affected by AOPA.

The approval and siting process for the development and expansion of feedlots can be time consuming and complicated. An increased

awareness of this process can assist feedlot operators in planning for the development or expansion of their operations. Prior to January 1, 2002, the approval process for feedlots was governed by the *Municipal Government Act*, municipal development plans, land-use bylaws and Alberta Agriculture, Food and Rural Development's *Code of Practice for Safe and Economic Handling of Animal Manures (Code of Practice)*, the *Water Act*, and potentially the *Public Highways Development Act*. Since January 1, 2002, the primary responsibility for feedlot approvals has been transferred from municipalities to the provincial Natural Resources Conservation Board (NRCB) under AOPA. (Additional information on the site selection and planning approval process is described in Section 3.)

2.1 Environmental Law Relating to Feedlots – Environmental Protection Standards

A. ALBERTA LEGISLATION

2.1.1 Agricultural Operation Practices Act

AOPA establishes specific environmental protection standards for new and existing feedlots.

www.nrcb.gov.ab.ca/aopa.html

2.1.1.1 Environmental Protection Standards

The *Act, Standards and Regulations* describe the specific standards that feedlot operators should understand.

The Act authorizes the NRCB to issue an enforcement order against a feedlot operator if

the NRCB is of the opinion the feedlot operator is:

- Creating a risk to the environment.
- Causing an inappropriate disturbance.
- Contravening the regulations.

2.1.1.2 Design and operating standards

The regulation describes the design and operating standards for livestock operations. Some of the standards apply to new and expanding feedlots, while others apply to all operations including existing feedlots.

Manure management. Feedlot operators are required to have sufficient land base to safely utilize the manure. The regulations contain tables for determination of land base. It is an offence to exceed the nitrate-nitrogen limits of the regulations, and the soil must be tested prior to application of manure if more than 300 tonnes are being applied annually.

Manure must be incorporated into the soil within 48 hours of being applied to the land. The regulations allow exemptions where the manure is being used on a forage or direct seeded crop. It also allows for restricted manure application on frozen ground where the land is flat and additional setbacks are maintained.

General setbacks for manure spreading are as follows:

- No manure is to be applied within 30 metres of a water well.
- A minimum of 10 metres separation must be maintained from a body of water where manure is being applied by subsurface injection and 30 metres where manure is applied by incorporation.

Manure storage and pen design. The regulations contain requirements for the design and location of feedlot pens and catch basins for new and expanding operations. The regulations state that catch basins must be able to hold nine months of manure runoff. The pen floors and catch basins must be constructed of such compaction to achieve a hydraulic conductivity of not more than 1×10^{-6} cm/sec. In addition, the regulation requires the side slopes of the catch basins be constructed appropriate for the stability of the soil. It also contains details regarding specific slope standards.

With respect to the suggested location of feedlot pens and catch basins, the regulations require a feedlot operator to:

- Avoid areas where there is a shallow water table.
- Maintain a minimum of 100 metres setback from a spring or water well and 30 metres from a body of water.
- Prevent surface water from entering the lagoon or catchment pond.
- Install a leakage detection system to monitor for potential contaminants.
- Implement fly control measures.
- Design for the bottom filling of the lagoon.
- Control access to the area and place warning signs.

Minimum Distance Separation. A Minimum Distance Separation (MDS) is required between new or expanding operations and their neighbours. The setback distances depend on the size of the new or expanding operation and the type of neighbour. The setback distances are measured from the portion of the operation closest to the neighbouring residence. For the purpose of measurement, the facility's manure storage is considered to be part of the operation.

The MDS does not apply to residences owned or controlled by the feedlot operator. It also does not apply where the neighbours themselves operate livestock operations and waive the MDS.

Records. The regulations require feedlot operators to keep records of any documents that were used to obtain approvals. In addition, all feedlots are required to keep the following records, if they apply more than 300 tonnes of manure per year:

- Volume or weight of manure produced.
- Legal description of the land to which the manure was applied.
- Date and volume of manure applied to land.
- Application rates and incorporation methods used.
- Information on any person the feedlot operator gave manure to, if more than 300 tonnes was given.

Feedlot operators are required to keep copies of these records for five years.

2.1.2 Environmental Protection and Enhancement Act

2.1.2.1 Prohibited releases

The *Environmental Protection and Enhancement Act* (EPEA) prohibits feedlot operators from releasing into the environment a substance in an amount, concentration or level or at a rate of release that causes or may cause a significant adverse effect on the environment. While “significant” is not defined in EPEA, “adverse effect” is broadly defined to mean the “impairment of, or damage to, the environment, human health or safety or property.” This means that a feedlot cannot release or spread manure, if the release or spreading of manure may cause a significant adverse effect to the environment. That is, if a feedlot operator spreads manure on land at a rate that will overload the nutrient value of the land, or if a feedlot operator releases manure on land where the manure will run into a water course, the feedlot operator will be in violation of EPEA.

EPEA also gives the government the power to issue an environmental protection order to an individual responsible for the release of an offensive odour, to order that individual to, among other things, prevent, minimize or remedy the offensive odour or destroy the cause of the odour. However, these powers do not apply to offensive odours that result from an agricultural operation that is carried on in accordance with “generally accepted practices” for that operation. There is no definition of generally accepted practices for similar agricultural operations. Whether a feedlot operator is following generally accepted practices will be decided by the Environmental Appeal Board or by a peer review board appointed by the Minister of Agriculture, Food and Rural Development.

2.1.2.2 Duty to report

EPEA requires feedlot operators to report any releases that may cause an adverse effect on the environment to Alberta Environment. Failure to report a release can lead to significant fines.

Typically, when a feedlot operator reports a release, Alberta Environment will require the operator to identify the steps that the operator is taking to prevent harm to the environment and to prevent the release from reoccurring.

2.1.2.3 Liability of officers and directors

If a corporation violates EPEA, any officer, director or agent of the corporation who was involved with the incident, even in a minor way, could face prosecution under EPEA. This applies whether or not the corporation itself is prosecuted for the violation and regardless of whether the officer, director or agent works for

a large corporation or simply a small incorporated family farm. This means that an officer, director or agent of a corporate feedlot operator is held personally responsible for violations of EPEA, if the officer, director or agent directed or participated in the violation in any way.

2.1.2.4 Strict liability offences

Offences under EPEA are “strict liability” offences. Unlike criminal offences, with strict liability offences, the courts are only concerned with whether the feedlot operator committed the offence, and not whether the feedlot operator intended to commit the offence. Nor are the courts concerned with the morality of

the operator’s actions. If a feedlot operator caused impairment to the environment by releasing manure into a watercourse, the courts will not examine whether the feedlot operator meant to cause the impairment, but only whether the feedlot operator caused the impairment.



If the feedlot operator did cause the impairment, the courts will convict the operator unless the operator can show that the action was in accordance with “due diligence” in running the operation and in carrying out the activity at issue. That is, if the feedlot

operator can show that all reasonable steps were taken to prevent the contravention of the EPEA, the operator will not be found guilty under the EPEA. Due diligence will be discussed in further detail in Section 2.1.6.1.

2.1.2.5 Fines

An individual is liable for a fine of not more than \$50,000 for each offence under EPEA and a corporation is liable for a fine of not more than \$500,000 for each offence under EPEA. Each day that a release or impairment occurs

is treated as a separate offence. For example, a release from a catch basin occurring over two days would be treated as two offences and would expose the corporation to a maximum fine of \$1,000,000.

2.1.3 Public Health Act

It is important for feedlot operators to be aware of the responsibilities regional health authorities have under the *Public Health Act* (PHA). The PHA gives health authorities significant powers to protect the public health. The PHA has priority over all provincial statutes, except the *Alberta Bill of Rights*.

The PHA allows a regional health authority, if it has reasonable and probable grounds to believe that a nuisance exists, to enter onto property to inspect the property, take samples of any substance or equipment being used and perform tests at the property. The PHA defines “nuisance” as:

“a condition that is or that might become injurious or dangerous to the public health, or that might hinder in any manner the prevention or suppression of disease.”

In order for the regional health authority to enter into the private place to perform these inspections and tests, the regional health authority requires either the consent of the owner, or a court order allowing these activities to occur. If the owner does not give his consent to the regional health authority

and the regional health authority applies to the courts to obtain an order, the PHA provides the judge with the authority to grant such an order without requiring the owner to have prior notice of the court application. Once the inspection, testing or taking of samples have occurred, if the regional health authority has reasonable and probable grounds to believe that a nuisance exists, the regional health authority can order the property to be vacated, declared unfit for habitation, closed or destroyed. In addition, the regional health authority has the authority to prohibit or regulate the selling of any livestock from the property.

As a result, should a regional health authority become aware of a public health hazard at a feedlot, the regional health authority can take steps to protect the public health and have the health hazard eliminated. In addition, if a feedlot operator contravenes the regional health authority’s orders, that operator is liable to a fine of not more than \$100 for each day the contravention continues.

2.1.4 Livestock Diseases Act

The *Livestock Diseases Act*, through its regulations, requires that the owner of a dead animal dispose of the dead animal within 48 hours of death, by:

- Burying it with a covering of at least four feet of earth.
- Burning it.
- Transporting it to a rendering plant for disposal.
- Natural scavenging with specific conditions.

If a feedlot operator fails to properly dispose of the dead animal, the feedlot operator is in violation of the *Livestock Diseases Act* and is liable to a fine of not more than \$10,000, or to imprisonment for a term of not more than one year or to both a fine and imprisonment. Feedlot operators should review *Destruction and Disposal of Dead Animals Regulations* for specific disposal standards.

B. FEDERAL LEGISLATION

2.1.5 Fisheries Act

2.1.5.1 Deleterious substance

Under the Canadian Constitution, the federal government has jurisdiction over the protection of fish habitat. To protect fish habitat, the federal government has enacted the *Fisheries Act*. The *Fisheries Act* prohibits anyone from depositing or permitting the deposit of anything into any type of water frequented by fish, which can have a “deleterious” or harmful effect on the fish. Further, the *Fisheries Act* prohibits anyone from depositing a deleterious or harmful substance in any place under any condition where the deleterious or harmful substance may enter any water frequented by fish. The *Fisheries Act* defines the phrase, “water frequented by fish” very broadly to include all internal waters of Canada. Therefore, this definition includes any creek, river, stream, lake or slough which are frequented by fish, including any creek which contains minnows in the spring, but dries later in the summer.

As a result, a feedlot operator commits an offence under the *Fisheries Act* when he spreads manure on land, located near a stream frequented by fish and the manure migrates

into the stream in sufficient quantities to have a deleterious effect. The offence results even if the deposit of the manure does not actually cause harm to the fish. The mere fact that the manure migrated into water frequented by fish causes a violation of the *Fisheries Act* and may result in charges under this Act, unless the feedlot operator can prove that at all material times, the water is not, has not been, and is not likely to be frequented by fish.

In addition, a feedlot operator risks committing an offence under the *Fisheries Act* if he spreads manure on land which has a stream frequented by fish, even if the deposit of the manure does not in fact enter the water, but had a reasonable chance of entering the water. The mere fact that the manure had a reasonable chance to enter water frequented by fish may violate the *Fisheries Act* and may result in charges under this Act. However, again, if the feedlot operator can prove that at all material times, the water is not, has not been and is not likely to be frequented by fish, then the feedlot operator has not committed an offence under the Act.

2.1.5.2 Liability of officers and directors

If a corporation violates the *Fisheries Act*, any officer, director or agent of the corporation who was involved with the incident, even in a minor way, is liable on conviction to punishment under the *Fisheries Act*, whether or not the corporation itself has been charged. As with the Alberta *Environmental Protection and Enhancement Act*, this is true regardless of

whether the officer, director or agent works for a large corporation, or simply a small incorporated family farm. This means an officer, director, agent of a corporate feedlot can be held personally responsible for violations of the *Fisheries Act*, if the officer or director directed or participated in the violation.

2.1.5.3 Strict liability offences

Similar to the Alberta *Environmental Protection and Enhancement Act*, offences under the *Fisheries Act*, regarding the deposit of deleterious substances or harmful substances into water frequented by fish, are “strict liability” offences. The courts are not concerned whether the deposit of deleterious or harmful substances was intentional. The courts are only concerned whether a feedlot operator deposited a substance into any type of water frequented by fish where the substance could have a deleterious or harmful effect on the fish. In addition, the courts are only concerned with whether a feedlot operator deposited a “deleterious” substance in any place under any condition where the

deleterious substance may enter any water frequented by fish. If a feedlot operator has done either of these actions, the courts can convict the feedlot operator unless the feedlot operator can show that:

- (1) At all material times, the water is not, has not been and is not likely to be frequented by fish.
- (2) The feedlot operator acted with due diligence to prevent the commission of the activity at issue.
- (3) The feedlot operator reasonably and honestly believed in the existence of the facts that, if true, would render the feedlot operator’s conduct as innocent.

2.1.5.4 Fines

An individual or corporate feedlot is liable to a fine not exceeding \$1,000,000 for the feedlot operator’s first deleterious substance offence and to a fine not exceeding \$1,000,000

or to imprisonment for a term not exceeding three years, or to both, for any subsequent deleterious substance offence.

2.1.6 Due diligence and environmental management systems

2.1.6.1 Due diligence

In order to avoid a conviction under the Alberta *Environmental Protection and Enhancement Act* and the federal *Fisheries Act*, a feedlot operator must have acted with due diligence in running the operation and in carrying out the activity at issue.

Whether a producer acted with due diligence in any particular circumstance will be determined by the courts on a case-by-case basis. Generally, the courts have indicated that to act with due diligence, one “must take all reasonable steps to avoid harm. However, that does not mean [one] must take all conceivable

steps.”¹ In addition, the courts have established that, “reasonable care and due diligence do not mean superhuman efforts. They mean a high standard of awareness and decisive, prompt and continuing action.”² In considering whether an accused acted with due diligence, the courts, “...examine what was done, what controls were in place, what was the state of technology that existed through the evidence of lay and expert witnesses to determine if the accused acted reasonably in the circumstances.”³

1. R. v. British Columbia Hydro and Power Authority [1997] B.C.J. No. 1744, paragraph 55.

2. R. v. Courtaulds Fibres Canada (1992) 9, C.E.L.R. (N.S.) 304 at 313 (Ont. Prov. Ct.).

3. R. v. Northwood Pulp and Paper (1992) 9, C.E.L.R. (N.S.) 289 at p. 293.

To determine whether environmental due diligence has been exercised, the court may examine the following:

- Did the feedlot operator establish and monitor a pollution prevention system? For example, is there a reasonable nutrient management plan for the operation?
- Did the feedlot operator ensure employees were instructed to:
 - Set up the pollution prevention system so that the feedlot complied with the industry practices and environmental laws and the permit conditions.
 - Report to the manager if the feedlot operator was not complying with the system? For example, if soil-testing analysis indicated high nitrate levels, making it dangerous to apply more manure, was management told?
- Did the feedlot operator review the environmental compliance reports provided by the operation's officers? Is there an annual review of the report and system?

- Did the feedlot operator ensure that its officers and employees promptly addressed environmental concerns brought to its attention by government agencies or other concerned parties? Was the problem fixed?
- Was the feedlot operator aware of the industry standards regarding environmental pollutants and risks?
- Did the feedlot operator address problems immediately?⁴

In addition, a court may examine whether a corporation has an environmental management system, what the environmental management system contains, how detailed it is, and whether it is followed by the company, to determine whether the company acted with due diligence in carrying out the activity in question.

2.1.6.2 Environmental management systems

Environmental management systems are used by corporations to establish and implement policies and procedures for operating an environmentally sustainable business. An environmental management system will examine the corporation's operations to determine the following:

- How the operations impact the environment.
- Which policies and procedures can be implemented to lessen or eliminate the operation's environmental impact.
- Which environmental standards and laws the corporation must follow.
- Whether the corporation is following these standards and laws.

The environmental management system will then put into place policies and procedures to reduce the feedlot's environmental impacts and to properly train the corporation's employees to meet and maintain the applicable environmental standards and laws. Finally, an environmental management system will provide for a periodic re-evaluation of these environmental policies and procedures.

Feedlot operators adopting an environmental farm plan are taking the preliminary steps toward the development of an environmental management system.

4. R. v. Bata Industries Ltd. [1992] O.J. No. 236 at page 24-25 (Ont. Prov. Div) online: QL (O.J.), rev'd in part on other grounds 14 O.R. (3d) 354, rev'd in part on other grounds 127 D.L.R. (4th) 438.

2.1.7 Common law of nuisance and the Agricultural Operation Practices Act

The common law of nuisance deals with an individual's unreasonable interference with a neighbour's use and enjoyment of the neighbour's land. If a feedlot unreasonably interferes with the use and enjoyment of a neighbour's land by creating offensive odours, excessive noise or dust, or the presence of flies, the courts may force the feedlot operator to pay damages to the neighbour to compensate the neighbour for the nuisance, which could force the feedlot to shut down.

However, the Alberta government enacted AOPA to offer protection to livestock operators from nuisance claims, as the government recognized that farms will typically produce some odours, noise and dust. AOPA states that a feedlot operator will not be liable in court for any nuisance resulting from the feedlot operation, nor will the feedlot operator be prevented from carrying on its operation by a court injunction or order, if the feedlot

operator has not contravened the local land-use bylaw and has followed "generally accepted practices for similar agricultural operations." The Act defines a "nuisance" to include an activity which:

- Arises from unreasonable, unwarranted or unlawful use by a person of the person's own property, which causes obstruction or injury to the right of another person or to the public and produces such material annoyance, inconvenience and discomfort that damage will result.
- Creates smoke, odour, noise or vibration which interferes with the reasonable and comfortable use of a person's property.
- Is found to be a nuisance at common law.

A peer review board appointed by the Minister of Agriculture, Food and Rural Development determines generally accepted practices for similar agricultural operations.

2.1.8 Common law of negligence

In law, an individual is negligent if he fails to live up to a "duty of care" he owes to another individual. A duty of care is a duty held by one individual to avoid carrying out an activity which has a reasonable chance of causing harm or injury to another individual. Of course, it is impossible for any individual to avoid all activities that might harm another individual. Therefore, the law sets standards of conduct that must be met. The standard is one of being reasonable – the individual must behave in the way that a reasonable individual of ordinary intelligence and experience would behave in the same circumstance. How an ordinary individual would behave depends on factors such as the degree of harm that might occur and standard industry practices.

A feedlot operator has a duty to operate in such a manner as to not cause harm to those individuals who could reasonably suffer harm

if the operator does not act reasonably in running the operation. For example, a feedlot operator may be negligent if:

- The operator spreads manure on frozen land that has a heavy slope towards a creek.
- The creek becomes contaminated from the manure spreading during spring runoff.
- The operator knew or ought to have known that neighbours receive their domestic water supply from the creek.
- The neighbours' health is affected by the contamination.

In this situation, the "reasonable" feedlot operator would know or ought to have known that spreading manure on these lands with these conditions could result in the neighbours suffering harm. As a result, the feedlot operator could be held liable for the harm or injury suffered by the neighbours.

2.2 Regulatory Approvals for Feedlots

Prior to January 2002, feedlot operators obtained approvals to build or expand a livestock operation from municipal governments through the issuance of a development permit.

The approval of livestock operations has been transferred to the Natural Resources Conversation Board (NRCB) under AOPA. Development permits are no longer required.

Under the AOPA, an "Approval" is required to build or expand the following sizes of feedlots:

beef cows/finishers (900+ lbs.).....	350 or more
beef feeders (<900 lbs.)	500 or more

Feedlot operators building or expanding to a size below these are required to obtain a "Registration." A Registration can be obtained from the NRCB through a streamlined review and approval process. In addition, feedlot operators seeking to build or modify a catch basin on an existing operation are required to obtain an "Authorization" from the NRCB.

2.2.1 NRCB approval process

The NRCB requires feedlot operators who are seeking an approval to provide the following (see Figure 2.1):

- (1) Name, address and telephone number of the applicant.
- (2) A list of the persons who live close to the proposed site and who may be affected by the operation.
- (3) An evaluation of whether the application is consistent with the applicable municipal development plan.
- (4) Engineering plans for manure storage facilities, manure collection area and contamination management.
- (5) Hydro-geological assessments.
- (6) Numbers and species of livestock and stage of animal development of the livestock that will be at the confined feeding operation.
- (7) Legal description of the land on which the confined feeding operation is located.
- (8) A site plan, to scale, showing the location of all:
 - water bodies.
 - water wells.
 - property lines.
 - residence locations of affected persons.
 - barns, corrals and pens.
 - manure storage facilities and manure collection area.
 - run-on and runoff controls.
- (9) An explanation of how the operation or expansion and its operation will meet the requirements of the *Act*.

- (10) The legal description of the land where manure is to be spread for the first three years of the operation.

- (11) A nutrient management plan.

Once an application is deemed complete, notice of the application is advertised in the local paper or notices are sent to those in the area of the proposed site.

Anyone wishing to comment on the application has 20 days to file a written statement of concern. The NRCB reviews the concerns and, if there is merit to the concerns, forwards the statement to the feedlot operator. The feedlot operator then has an opportunity to respond to the statement of concern.

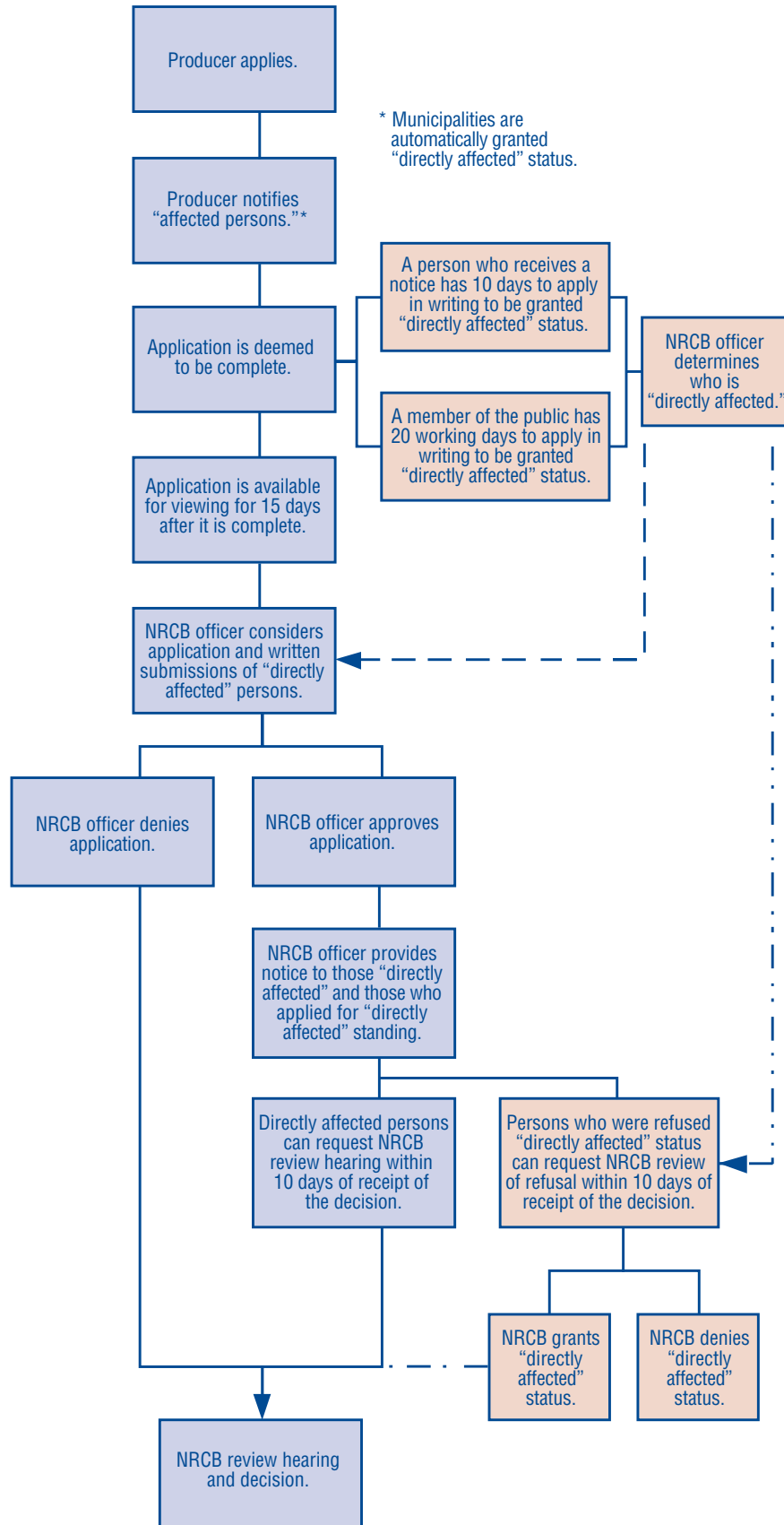
Once the NRCB is satisfied that the statement of concern has been addressed and the requirements of the *Act* and regulations met, the Board can issue an Approval for the project.

Those persons who filed a statement of concern and who were found to be directly affected by the project, are given notice of the Approval and provided an opportunity to request that the Board review the approval. The NRCB will convene a review hearing at which the Approval with either be upheld or refused.



Figure 2.1

The NRCB Approval Process



2.2.2 Water Act Approvals

2.2.2.1 Process

A feedlot operator building a new livestock operation may require either a water approval or a water licence under the *Water Act*. The *Water Act* became law in January 1999.

A water approval is required for the undertaking of an “activity.” Under the *Water Act*, an activity includes the construction, operation or maintenance of a structure that may:

- Alter the flow or level of water.
- Change the location or direction of flow of water.
- Cause the siltation of water.
- Cause the erosion of any bed or shore of a body of water.
- Cause an effect on the aquatic environment.

If it is necessary for the feedlot operator to divert and use more than 6,250 cubic metres of surface water or groundwater per year, a water licence is required.

Applications for an approval, or licence are submitted to Alberta Environment. In the application for either an approval or a licence, a feedlot operator should include the plans for the project, including:

- Scaled drawings.
- The legal land location.
- Details regarding the affected water bodies.

- The location of any structures to be built or affected.
- The rate of diversion and the anticipated quantity of diversion.

In addition, the feedlot operator should include reports related to the project, including a description of the project and hydrologic information regarding the project.

Once a feedlot operator has submitted the approval or licence application to Alberta Environment, the department will require the feedlot operator to publish a notice of the application in one or more issues of the local newspaper in the area of the proposed approval or licence. The notice of the application will include, among other things, the location of the activity, the name of the applicant, a description of the activity or diversion and an indication that if any individual is directly affected by the application, a statement of concern can be submitted to Alberta Environment within a certain period of time.

A feedlot operator may be asked to publish a joint notice for the water licence and NRCB Approval in order to streamline the approval process.

2.2.2.2 Environmental Appeal Board appeals

If the feedlot operator’s application for a water approval or licence is granted, Alberta Environment will require the feedlot operator to publish a notice of the approval or licence in one or more issues of the local newspaper in the area of the proposed approval or licence. The notice of the approval must indicate that an individual who submitted a statement of concern to Alberta Environment regarding the application, can file a notice of objection to the Environmental Appeal Board within a certain period of time. In addition, if the feedlot

operator’s application for a water approval or licence is denied, the feedlot operator can file a notice of objection to the Environmental Appeal Board regarding the denial within a specific period of time.

If a notice of objection is filed with the Environmental Appeal Board, the board will conduct a hearing. In ruling on an appeal, the Board may confirm, reverse or vary the decision of Alberta Environment. A decision of the Environmental Appeal Board can be appealed in very limited circumstances.

2.2.3 Transportation approvals

The *Highway Development Control Regulation* under the *Public Highways Development Act* prohibits the erection or placement of a development within 300 metres of a primary highway and 800 metres from the centre point of an intersection of a primary highway and another highway or public roadway. As a result, if a feedlot operator plans to construct a feedlot within these distances from a primary highway, the feedlot operator will be required to apply for and obtain a Roadside Development Approval from Alberta

Infrastructure to construct a development near a primary highway. The Roadside Development Approval will set out the road access and setback conditions for the development.

If a feedlot operator is required to apply for a Roadside Development Permit, the feedlot operator should include the engineering drawings, the property description, the existing and proposed land-use and the closest distance of the proposed development to the highway property line.

Addendum

The information provided regarding the environmental obligations and the approval process for feedlot operators in Alberta is for information only and should not be relied upon as legal advice. The feedlot operator should consult a lawyer, as the facts of the feedlot operator's situation may change the feedlot operator's legal rights or the law may change.

Additional information on these issues can be obtained from Alberta Agriculture, Food and Rural Development's extension staff, the Natural Resources Conservation Board, consultants and lawyers.

Copies of the Acts and Regulations can be obtained online or via mail from the Queen's Printer.

- AAFRD 1-866-882-7677
www.agric.gov.ab.ca
- NRCB 1-866-383-6722
www.nrcb.gov.ca
- Queen's Printer 1-780-427-4952
www.qp.gov.ab.ca



3.0 SITE SELECTION AND PLANNING

3.1 Site Selection

The selection of a site for a feedlot is an important decision that has a strong influence on the economic and environmental sustainability of an operation.

A good site will provide many of the elements required for a feedlot to be successful in both the short and long term. Feedlot operators must balance the economic forces affecting their operation with consideration of issues such as environmental protection, animal welfare, food safety and other stakeholder concerns.

Selection of the appropriate site for feedlot development will also provide the opportunity to meet longer-term goals such as future expansion. Expansion opportunities are largely determined at this time and therefore should be considered when selecting a feedlot site.

Whether selecting for a large commercial feedlot or a small backgrounding operation, the site selection principles remain the same. However, finding an appropriate site for a large feedlot may require additional investigation to accommodate present and future needs. All beef cattle feedlots require similar resources to operate effectively, while ensuring environmental sustainability and acceptable levels of impact on neighbours and neighbouring land uses. The size of the feedlot does not change these requirements, only the level of demand and the magnitude of potential impacts.

Expansion of an existing feedlot will require equal consideration of the feedlot's business plan resource requirements and environmentally sustainability issues.

This section will provide feedlot operators with the basic process for site selection. When considering a new or expanded feedlot,

operators should contact the Natural Resources Conservation Board (NRCB) Approval Officer for information and advice.

When evaluating potential sites, it is important to include the interests of other stakeholders, such as neighbours (residence and landowner) and the local municipality.

The following steps outline the process that follows the business plan:

- Assess local/community perception of feedlot developments.
- Gather development application requirements from the NRCB.
- Evaluate the ability of the site to meet development requirements of Minimum Distance Separation (MDS), land base, soil and groundwater investigation.
- Evaluate resource base, water supply, land, and rural services.
- Complete management plans as they relate to specific site.
- Share intent with stakeholders.
- Complete and submit required applications.
- Build upon approval, or return to development process.

When a suitable site has been located, based on the preceding checklist, apply to the NRCB for the approval. To speed up the decision-making process, work with the NRCB Approval Officer to ensure all the necessary information is included. The permit process is dependent on having complete information for the application. Delays in providing this information will delay both the process and a decision on the application.

Refer to the NRCB offices or Web site www.nrcb.gov.ab.ca/ILOpage.html for an application form.

3.1.1 Assess local/community perception of feedlot developments

Assess community and neighbours' perceptions of the feedlot industry and the potential development. Determine how previous concerns regarding livestock developments in the area were handled. Identify community

and local leaders who will have an impact on or be impacted by the development. This allows analysis of the risk of future opposition and saves time and money. It is important to address all concerns, both real and perceived.

3.1.2 Gather development approval requirements

At this stage, producers should contact the NRCB Approval Officer to determine application requirements. The Approval Officer will describe the applicable approvals required under the *Agricultural Operation Practices Act (AOPA)*, *Water Act* and *Public Lands Act*.

The application form must contain all the necessary approvals for the feedlot operation (e.g., an application for *Water Act* licence from Alberta Environment). Once the application is prepared and submitted to the NRCB, the Approval Officer screens the application to ensure the necessary information is included. The Approval Officer will then forward the completed application to other agencies for approvals, such as a *Water Act* licence. Alberta Environment is responsible for the allocation of water resources, under the *Water Act*. Any water diversion also requires a permit from Alberta Environment.

The application is reviewed to ensure that it has all of the relevant information required to make a decision on the application. Once this information is provided, the application is deemed complete. Depending on the size of the operation (approval vs. registration), the NRCB may be required to notify affected parties

of the proposed operation. Municipalities are always notified of an application.

Parties that might be affected by the operation, such as neighbours or municipalities, may submit statements of concern. These statements of concern will be reviewed. Attempts will be made to resolve issues raised by affected parties. Once all the input from the municipalities, Alberta Environment (*Water Act*), etc., have been received, the Approval Officer makes a decision on the application. The Approval Officer has three options: to approve the application, reject it, or approve with conditions.

An approval for the development must be issued before construction begins on the feedlot operation.

Regional health authorities, Alberta Environment, Sustainable Resource Development (Public Lands) and Alberta Transportation may receive referrals on development applications. These provincial government agencies have the responsibility to investigate and take action if a livestock operation has or exhibits the potential to have significant negative impact on public health, the environment or transportation infrastructure.

3.1.3 Conduct a site assessment

Assess the site's capacity to meet the geographical, physical and regulatory requirements of a livestock development. A general assessment of the geographical requirements of the development should have been done in the business plan phase. Assess the site based on its ability to provide convenient access to the infrastructure and resource base required to manage the proposed operation.

Ensuring suitable climatic conditions is generally not a pressing issue, as most locations in Alberta have a climate suitable for successful beef production. However, there may be local factors that influence the siting of the development such as wind, air drainage, other livestock operations and environmental concerns.

3.2 Siting Considerations

3.2.1 Minimum Distance Separation standards (MDS)

MDS is the setback or buffer established between the outside walls of neighbouring residences (not property line) to the point closest to the developing livestock facility, manure storage, runoff catch basin, compost area,

feeding pen or barn of the Confined Feeding Operation (CFO). MDS for various sizes of livestock operations are identified in AOPA, Schedule 1 (www.nrcb.gov.ab.ca/aoparegs.html).

3.2.2 Setbacks from physical features

Proper site selection includes a constant awareness of environmental sustainability. Each site consists of a unique set of physical circumstances that include topography, surface

water (both seasonal and continuous) and physical barriers, such as trees. These features also need to be considered when evaluating a potential site.

3.2.3 Separation between livestock operations

Consider other livestock operations when selecting a site for a new operation. Providing an adequate separation distance from other livestock operations is an important step in preventing the spread of livestock disease and

cumulative nuisance effects. Consult a veterinarian to determine adequate separation distances from other livestock to prevent the transfer of disease.

3.2.4 Separation from water bodies

Protection of surface water involves both appropriate siting and manure management. Properly designed and constructed feedlot pens are not considered to be manure storages. However, feedlot catch basins are considered to

be manure storages. For information on the siting of the structural component of a feedlot, refer to AOPA (www.nrcb.gov.ab.ca/aopa.html).

3.2.5 Steps to avoid nuisance

All physical elements of the site will have an impact on potential nuisance levels. Prevailing wind intensity, direction, duration and frequency play an important role.

Wind. Prevailing wind is an important factor to consider, but the direction can vary between seasons. During summer, when odours are more intense and neighbours are outdoors more often, it is important to consider the direction of the prevailing winds. Also consider the effects of the absence of wind on summer evenings; for example, under calm conditions, odours will not disperse as readily.

Air drainage. Under calm, summer conditions, the air near the ground can cool and drift down a slope. This is known as air drainage. This may occur frequently during calm summer evenings. This is also the time when people are most likely to be outdoors.

Annual precipitation levels are also an important consideration. Topography and elevation will also have an impact. Natural physical features can provide both visual screening and actual filtering. Awareness of the unique physical features of the site will enhance utilization of its strengths, and help to manage its weaknesses.

3.2.6 Permeability of the site

A primary component of feedlot site selection is protection of the groundwater. Soil physical characteristics must ensure a

maximum permeability rating. Avoid porous soils or sites that may consist of fractured bedrock.

3.2.7 Groundwater investigations

Groundwater investigations are required to confirm site suitability. The proposed site must offer water conditions that minimize the potential for groundwater contamination.

Water table evaluation will impact the design and cost of manure storage structures. Avoid shallow groundwater areas or areas close to surface water bodies.

3.2.8 Evaluate resource base

Determine whether the site offers the required resource support necessary for the proposed operation. This will include

availability of water, feed or land base necessary to produce feed and proximity to purchased input requirements and labour.

3.2.9 The water resource

An integral part of site selection is the availability of a reliable water source for livestock consumption.

- An ample supply of good quality water is essential to any livestock operation.
- Water quantity is usually more important than water quality.

- Water requirements will vary with animal size, air temperature, diet, moisture content of the feed, and water quality.

The following chart, summarized from information developed by the Department of Animal Science, University of Nebraska, gives an estimate of water intake of feedlot cattle at different weights and average air temperatures.

Figure 3.1 Effect of Temperature on Water Intake

Average temp.	Animal weight			
	600 lb.	800 lb.	1000 lb.	1200 lb.
2°C	5.5	7	8.5	9.5
10°C	6.5	8	9.5	10.5
20°C	8.5	10	12	14
25°C	9.5	12	14	16
30°C	14	17	20	22.5

Conversions: 1 U.S. gallon = 3.8 litres, 1 U.S. gallon = 0.8 Imperial gallons

As a rule of thumb, a typical Alberta feedlot, holding cattle weighing 250–550 kilograms, will use about 38–57 litres of water per head per day, but that could increase to about 76 litres per head per day on peak demand days. Design the system to supply 152 litres/day during peak consumption (e.g. finished cattle on high-energy ration during hot summer). The following factors should also be considered:

Water sources. In Alberta, water wells and dugouts are the most common sources of supply. Preferred are wells that can supply a consistent quantity of quality water. Dugouts are used where groundwater is not an option. These dugouts are filled by collecting spring

runoff or are filled from irrigation canals, creeks, rivers, or lakes.

Wells and water licensing. It is extremely important that the amount of water pumped from a well does not exceed the recharge capacity of the aquifer supplying the well. If the recharge is exceeded, the groundwater will be “mined,” and the operation will not be sustainable.

Before starting construction of a feedlot, assess the groundwater potential. This is not only good planning; it is required as part of the licensing process administered by Alberta Environment. The onus is on the developer to prove that water supplies are adequate.

The best approach is to consult with a hydrogeologist (AAFRD, PFRA, or private), to assess the groundwater potential for the area, supervise the drilling and testing and assist with the licensing process.

A water licence must be applied for under the *Water Act*. The well must be constructed to Alberta Environment standards and may only tap into one aquifer. The well must be pump tested for at least 24 hours and the results must be interpreted by a qualified hydrogeologist to estimate the safe yield of the well. A survey of neighbouring domestic water requirements and other well licences in the area will also be required. Ongoing monitoring of water use and water levels may be required as conditions of the licence.

Once a licence is issued, the operation will have first priority on the amount of water that is stipulated by the licence, over any other licensed users that apply later.

For more detailed information on licensing contact an Alberta Environment office at:

Peace River: 780-624-6167

Stony Plain: 780-963-6131

Edmonton: 780-427-5296

Red Deer: 403-340-7740

Calgary: 403-297-6675

Lethbridge: 403-381-5994

Dugouts and water licensing. The size of dugout required for a given feedlot will vary with the water requirements of the operation, the refill frequency of the dugout and assumptions for seepage and ice thickness.

Dugouts that are filled only by spring runoff should be designed to hold at least a two-year water supply, unless an alternative source can be used to fill the dugout in a drought year. Dugouts in the irrigation area of the province or dugouts adjacent to rivers or lakes must be at least large enough to supply water from the time the water is not available in the fall until water flows again in the spring. A one-year storage capacity is the recommended capacity for these dugouts. Planning and design information is available through Prairie Farm Rehabilitation Association (PFRA) or Alberta Agriculture, Food and Rural Development (AAFRD) water specialists.

Dugout water sources for feedlots will also require a licence. The licence protects the licensee from other water users that may be competing for the same water. If a new water user (other than a household) has a negative

impact on a feedlot's water supply, the feedlot operator will have priority for the licensed amount. When issuing a licence, Alberta Environment will want to ensure that the water use will not negatively affect other licensed users, household users or the watershed itself.

Approvals are also required to pump water from lakes and rivers, even if the situation is temporary.

For licensing information, contact Alberta Environment at the numbers listed above or through their Web site: www.gov.ab.ca/env/water/Legislation. Feedlot operators can also link to the Alberta Environment's site through Ropin' the Web at www.agric.gov.ab.ca.

Steps to prevent contamination of wells and dugouts. Agricultural activities around a well or dugout may have negative impacts on water quality. To prevent well and dugout contamination, ensure the following:

Wells

- Wells must be properly constructed and sealed.
- Locate wells up-slope, away from sources of contamination.
- Properly plug any old unused wells to prevent contamination of newer wells.
- Do not over-apply manure; nitrate seepage can contaminate groundwater.
- Build manure storage structures or catch basins so that they will not seep into groundwater.

Dugouts

- Construct dugouts in proper drainage areas, away from potential sources of contamination.
- Apply manure and fertilizers to meet crop nutrient needs. Excess soil nutrient levels can lead to excess nutrient levels in the runoff water. This causes increased algae and weed growth in dugout water.
- Do not spread manure on snow or frozen ground. If it is necessary to do so, follow AOPA, Schedule 3. Research in Manitoba showed 10 to 60 times as much phosphorous in spring runoff from winter-spread fields, compared to control fields.
- Maintain manure storages, catch basins, sewage lagoons to prevent runoff or seepage.

Contact the local AAFRD Water Specialist to develop a plan to protect the operation's water resource.

3.3 Water Quality

Water quality assessment should consider:

- Mineral content.
- Aesthetic qualities (taste and odour).
- Microbiological quality or biological parameters.
- Depending on the water quality, feedlot diets should be adjusted for any excesses or deficiencies in water quality. Contact a nutritionist.

Mineral content

- If the Total Dissolved Solids (TDS) is less than 1,000 mg/L, the water is likely of excellent quality.
- If the TDS level is high, nutritionists may adjust the salt levels and salt type in the ration to compensate for the water.
- TDS over 3,000 mg/L is questionable, but the suitability will depend on the specific minerals in the water.

Sulphate

- Sulphate levels over 500 mg/L may interfere with copper (and other trace mineral) absorption and can have a laxative effect on some animals.
- High sulphate levels give water a bitter taste and cattle will not drink it if there is an alternate water source.
- Information on the maximum sulphate level is quite variable. As a general rule, less than 1,000 mg/L is acceptable. Levels over 1,500 mg/L caused reduced weight gain in one study. Very high levels of sulphate in water and feed can cause a brain disorder called polioencephalomalacia. If using high-sulphate water, monitor animal performance closely.

Nitrate. Levels less than 100 mg/L are considered safe for livestock, but levels over 10 mg/L can be considered contaminated and unsuitable for human consumption. The 100 mg/L level is a conservative figure, based on the potential for nitrate poisoning in weak, young or pregnant animals. Most feedlot animals should be able to tolerate higher levels. High nitrates in the feed supply can compound the problem. Nitrate poisoning symptoms include bluish or brownish discoloration of nonpigmented areas (around the eyes and mouth), sluggish or staggering gait, rapid heartbeat, frequent urination and laboured breathing. Elevated nitrate levels are a warning sign of nitrate poisoning. Investigate the source of nitrate and eliminate, if possible. Seepage from manure stockpiles, inactive feedlot pens, or over-application of manure are the most likely sources of nitrate in water.

Taste and odour. Taste and odour qualities of the water supply are often overlooked, but

can be very important. If the water tastes or smells bad, livestock will consume less. Odours, such as hydrogen sulphide, can reduce water consumption and affect production. These odours are usually associated with decaying aquatic plants and algae in dugouts. Some wells also contain significant levels of hydrogen sulphide.

Biological parameters. Pathogenic organisms may be present in manure. Maintain a good water supply by minimizing the risk of manure contamination. Fecal coliform bacteria tests are used as an indicator of fecal contamination. These bacteria will not likely cause illness themselves; however, their presence may suggest the presence of other fecal pathogens. Several diseases can be spread through animal waste including leptospirosis, and salmonellosis. Parasites can also be spread through contaminated water, e.g., *Cryptosporidia*, *Giardia*.

Another major biological concern is algae toxin. Heavy blooms of blue-green algae can result in animal illness or death. These algae can be a problem in surface water sources. Thriving in warm stagnant water, they can kill animals within minutes. Control algae blooms with appropriate treatment of the water reservoir. Often simple aeration will prevent the conditions preferred by toxic species. Treatment with hydrated lime, alum or copper sulphate will often control algae. It is important that algae be controlled before they become a problem.

Often an adjustment period is required when cattle are moved. Sometimes, to maximize production, poor quality water must be diluted with better quality water during this adjustment period.

Land base. The land base must meet the agronomic and proximity requirements to be economically feasible. In short, the land needs to be suitable for the required crop production and close enough for economic feed production and manure application. The land base required must be based on the agronomic use of manure. It may be necessary to engage in spreading agreements with neighbours or explore alternate uses for the manure. For the minimum land base requirements, contact the development officer at the NRCB and review AOPA, Schedule 3.

Rural service. Any off-site inputs require reasonable access to related agribusiness and human resource sources. Good road access to the site is critical. The availability of utilities, such as power and gas, are also significant factors affecting site selection.

3.3.1 Complete management plans as related to specific site

It is extremely important for feedlot producers and the stakeholders, that clear, functional and appropriate management plans are developed. This includes the overall operational plan as it relates to AOPA. A comprehensive nutrient management plan, with supporting records, is also to be completed as per AOPA. The management plan should outline pen management, transport to storage,

storage period and land application as directed by the nutrient management plan, as well as information on disposing of waste, such as dead animals and pesticides (see Section 8).

It is important to be prepared with a clear, informed message regarding management intentions as they relate to minimizing nuisance (specifically odour) and meeting the requirements for a livestock operation.

3.3.2 Share intent with stakeholders

A new project generally represents some form of change to a community. Typically, 5 to 10 percent of community members will support the project initially and 5 to 10 percent will oppose it. Opponents or supporters are unlikely to change their position. The remaining 80 percent, called the silent majority, are either undecided, indifferent or skeptical about the project. Failure to bring the silent majority on side can lead to opposition and can seriously jeopardize the project. Various communication strategies can be used to win the support of this group. Open public participation is one communication strategy that has proven to be successful.

It is wise to begin by consulting with the community. This helps to build trust, understanding and support for the project. If the project proceeds too far before the public is informed, there may be problems with rumours and misinformation. Under AOPA, directly affected parties will be notified by the NRCB and will have an opportunity to review the application and raise concerns. Members of the public will also have an opportunity to review an application for an approval and may also submit statements of concern together with reasons why they should be considered to be directly affected parties.

Public participation is not the only way to gain community support, but it is a powerful approach for paving the way. The following points outline key considerations and communication strategies for public participation in a successful project.

Knowing your community is critical to building support. One of the first steps is to identify the individuals and organizations in the community who will be affected by the project. How might they be affected? What information do these individuals want and need? Could the project be changed to better meet their needs? What is the history of the community? What areas had problems initiating new projects in the past? Who are the people with power and influence? What is the perspective of community stakeholders? Gathering this type of information helps to develop a community's social profile. This profile is vital to effective communication strategies.

Keep the community informed. To build community support for the project, ensure that the community is well informed and, ideally, part of the initial planning for the project. Any communication about the project must be open, honest and timely. Keep in mind there are a variety of approaches suitable for reaching different groups.

To reach young families, communicate through the school newsletter or parent advisory meetings. The seniors' activity centre is a good place to reach that interest group. Quick lunch hour gatherings in a central location might appeal to the working crowd. Some approaches may be more effective at different developmental stages of the project. Consider which information to share, who to communicate with and when. Do not always rely on print material or meetings to get the message across. Try to use a creative variety of public participation approaches to provide information and receive feedback.

Gather meaningful feedback from the public. Inviting the public to express its views and concerns about the project can enhance community support and ultimately the success of the project. As initiators of the project, be prepared to listen, respond and incorporate feedback given by community members.

If the community does not support the project, stand back and try to be objective. It may be that not enough information has been provided. Perhaps the timing is off, or the location is wrong. Take advice from the community and let its members know where their input has made a difference. If the intention is not to use feedback, do not ask for it.

There is no integrity in the public participation process if the decisions are already made. By allowing the community to provide input, it will attach some ownership to the project.

Plan communication strategies. These strategies have proven to be effective in communicating with the public and building support for a community project:

- Informal consultation.
- Use of media.
- Open house.
- Fact sheet with tear-off response.
- Reference centres.
- Public forums.

3.4 Site Plan Highlights

Once a site has been located, a site plan is required. The location and orientation of structures can influence the potential for environmental impacts. Good site planning can also prevent neighbourhood disputes. When designing a site plan, consider the following:

- Adhere to required permit criteria, such as setback distances from roads and property lines or water diversion pathways.
- Locate buildings and storage facilities for fuel, fertilizer, manure, compost or pesticides at least 100 metres from springs and wells and 30 metres from common bodies of water. If possible, choose a site with lower elevation than wells to prevent runoff or seepage of harmful substances into the water supply.
- Locate buildings and facilities on an adequately drained site, being careful to avoid low areas subject to flooding. Refer to AOPA for recommendations on site planning.
- Grade the area to divert polluted runoff and prevent it from entering surface or groundwater.
- Grade or berm outside yards to allow collection of contaminated runoff before it reaches surrounding waterways and to reduce nuisance impacts on neighbours.
- Ensure that emergency vehicles can access facilities in case of fire or other emergency.
- Position high activity buildings and work areas away from neighbours to minimize sight and sound impacts.
- Use screens, such as tree shelterbelts, to provide wind protection and reduce the operation's impact on adjacent property owners.
- Divert roof runoff and any clean water away from the site.
- Adhere to the recommendations of the Canadian Farm Building Code.
- Invest in good storage and processing facilities for feed and feed ingredients. Adequate facilities and proper management can help prevent pollution and reduce losses due to spoilage, insect and rodent damage and fire from spontaneous combustion.
- Before building new feed storage facilities, a complete storage and handling system should be designed. This design should incorporate both present and future requirements.
- Locate the feed processing and handling centre in an area that will allow large vehicle access and provide sufficient setback from neighbours. This will ensure they are protected from noise, dust, traffic and the threat of fire.

3.5 Managing Feedlot Shutdowns

Whether a feedlot is shut down for a few weeks, a few months or is permanently decommissioned, specific steps are necessary to protect people, the environment and animals. The unused feedlot poses a risk to surface and groundwater quality. It is also a potential health and safety concern for humans and neighbouring animals.

The development approval may define the period of time a facility is allowed to be empty before another approval is required for the operation. Under AOPA, the owner or operator of land or buildings that are a confined feeding operation must remove the manure from the land or buildings within one year, or a shorter or longer term set by the Board. For a feedlot shutdown, check with the NRCB or local municipality for decommissioning requirements.

For the purposes of this section, a feedlot is defined as an uncovered, outdoor feeding facility for any type of livestock and includes both paved and unpaved feeding areas. A few factors (such as soil nitrate accumulation and soil cracking) apply only to unpaved lots.

General points to remember when shutting down a feedlot:

- No matter how short the shutdown period, take steps to minimize the risk of unauthorized entry of people and animals, into storage areas and ponds. Manage debris basins and runoff ponds to prevent discharge and contamination of wells.
- During short-term shutdowns of one month or more, turn off water and unnecessary gas and electricity. Control weeds and insects and remove manure from the area.
- For longer-term shutdowns of six months or more, conditions of the permit and regulations may require a cleanup procedure within a certain time period.
- For a permanent shutdown, the area needs to be returned to crop production or other land use. For decommissioning (that is, termination of permitting conditions), notify the permitting authorities. Some jurisdictions may also require a demolition permit for site cleanup.

3.5.1 Site security

When a feedlot is shut down, the site must be secured to prevent trespassers. Post warnings and fence hazardous areas, such as storage structures, dugouts and water basins. The absence of regular worker traffic and monitoring makes abandoned sites prone to

invasion by the curious and the criminal. Such unknowing individuals can put themselves in dangerous situations and the property owner at considerable liability unless responsible precautions are taken.

3.5.2 Removing solid manure

Remove manure. Even for a short-term shutdown, remove as much manure as possible down to the soil surface, immediately after the animals are removed. Manure removal is essential to reduce the risk of contaminants moving down to the water table or being carried by runoff to streams and lakes.

In an active pen, hoof action and compaction by the animals create conditions that minimize movement of nitrogen and salts into the soil below the manure pack. However, after removal of the animals, soil cracking (due to drying, freeze-thaw cycles, and other activities) changes the pen floor from mainly anaerobic to aerobic

conditions. Aerobic conditions allow relatively immobile organic and ammonium nitrogen to be converted to mobile nitrate-nitrogen. The cracked soil may allow water to infiltrate deeply, thereby increasing the risk of nitrates reaching the water table.

Manure must be completely removed from fence lines and beneath feed bunks. This controls rodents and insects, preventing them from becoming problems for neighbouring farms. Whether the shutdown is short-term or permanent determines whether cleaning or complete removal of fences and feed bunks is most appropriate.

Haul manure away. In most cases, manure should be hauled for application on cropland or to a composting area soon after shutdown. Stockpiling manure is recommended only when field/soil conditions are not conducive to spreading. If stockpiling is necessary, control runoff seepage and odours from the

stockpiling area, as well as insects, birds and rodents. Long-term stockpiling requires proper site design to protect surface and groundwater. Seek professional engineering advice on siting and design of stockpiling areas.

Apply manure to cropland at rates to meet anticipated crop needs (see Section 5).

3.5.3 Establishing plant cover

Plant cover. If the pen or feedlot is to be shut down for either a season or permanently, establish a plant cover as soon as possible. High nitrogen levels remain in the soil beneath the pens even after manure is removed. Plant cover will utilize the nitrogen before it moves down to the water table. As well, plant cover will reduce soil erosion. Crop production may also provide some economic returns.

Avoid fallowing. It greatly increases the risk of nitrates and other contaminants reaching the water table.

Soil sampling. Crop yields will likely be low in the first few years due to poor soil structure and to excess nitrogen and salt in the soil. Take soil samples for analysis to determine salt content, nutrient requirements and appropriate crop options (see Section 5).

Salt. In pen areas, much of the salt is concentrated in the top 30 centimetres of soil. In this layer, only very salt-tolerant crops will grow in the first few years. If sodium is the main salt of concern, gypsum may be applied to promote leaching of the salts.

Remove salt-laden layer. To speed crop establishment, remove the top 30-centimetre layer of salt-contaminated soil before seeding. This allows growth of moderately salt-tolerant crops. Take care to avoid simply moving

the salt problem to a different area. Seek professional agrologist advice on site-specific soil remediation and land spreading.

Use perennials. A perennial crop is often a good choice for reclaiming a feedlot area. Tillage can aggravate the salinity problem. Perennials also have a high capacity for drying out the soil, which increases the potential for leaching of salts from the soil surface. Deep-rooted perennial crops, such as alfalfa, greatly enhance recovery of nitrogen located deep in the soil profile.

Supplemental water needs. Any crops grown on former feedlots are very susceptible to drought due to high nitrogen availability, poor soil structure and high salt levels. Therefore, it is often beneficial to have supplemental water available when reclaiming a feedlot for crop production.

Remove harvest residue. Even if crop growth is poor, remove any harvested plant material to rid excess nutrients and salts from the site.

Test nitrate levels. Before feeding forage harvested from former feedlot sites, test the forage for nitrate accumulations. High levels of available soil nitrogen can result in high nitrate levels, particularly if the forage crop has had any sudden stresses such as drought, hail or frost.

3.5.4 Feeding areas

Clean feed bunks. Even for a short-term shutdown, clean the feed bunks and remove all debris. Feed can attract birds, such as sparrows and pigeons, which can be a nuisance to neighbours and contribute to spreading of weed seeds.

Check around feed bunks. Feed bunks and watering bowls set on risers. Scrape the debris and spread on cropland. The space and debris beneath the feed bunks and bowls attract rodents and provide a medium for insect reproduction.

Rodent control. If there is evidence of rodents, take control steps to help maintain Alberta's rat-free status. If rats are observed or suspected, contact a pest control officer in the local municipality, or a vertebrate pest specialist with AAFRD.

Feeding aprons. If built with slab-on-grade construction, rodent control is more difficult. The lack of cattle and vehicle traffic allows rodents undisturbed use of the space beneath the slabs. (New construction should include vertical foundations or grade beams at the edges of all slabs to reduce rodent burrowing.)

3.5.5 Feed storage

Bins and silos. Unless silage and grain products are stored in rodent-proof bins or silos, they soon become a major site for rodent reproduction. If silage is stored for future use in open bunker or trench silos, the exposed areas should be smoothed and covered with appropriately-supported or weighted plastic to minimize spoilage.

Clean up tires, plastic. If materials, such as old tires, are used to weight the plastic on bunker and trench silos, accumulated water in tires and discarded plastic can become a reservoir for mosquito breeding. Either prevent water from accumulating or dispose of the tires in accordance with provincial regulations. For more information on tire disposal, contact the Tire Recycling Management Association of Alberta.

Clean up spilled feed. Spilled feed and grain around feed mixing and storage areas attracts rodents, birds and sometimes insects, increasing risks such as disease spread, environmental degradation and problems for neighbours. Clean up spilled feed and use as feed if suitable, or spread it on agricultural land. Feed contaminated with toxic materials must not be fed to livestock. Dispose of contaminated feeds in a manner appropriate to the contaminant.

Eliminate debris. Remove and properly dispose of all debris, such as plastic or other materials. Store lumber above ground to minimize possible rodent habitat.

- For decommission, the feed may be transported to be used by other livestock operators in the area. Old or spoiled silage should be removed and applied on agricultural land.

3.5.6 Utilities

Turn off utilities. During shutdowns of one month or more, turn off all unnecessary utilities such as water, gas and electricity to reduce the risk of erosion, wasted water, injury and fire in the event of damage to a service line by cleaning equipment or failure due to general deterioration.

Drain water lines. If shutdown occurs during freezing weather, drain water lines and watering bowls. A high-airflow capacity commercial air compressor can be used to

remove water from lines that are not graded for self-drainage. Drain water tanks to prevent freezing and accumulation of stagnant water conducive to mosquito breeding.

Inspect electrical wiring. Many feedlots use electrically heated watering bowls. When the feedlot is returned to service, thoroughly inspect and test all systems. Faulty or improperly wired watering bowls can result in trickle voltage or even electrocution of cattle.

3.5.7 Water wells

Check wells. Even for a short-term shutdown, check all water wells to ensure they are properly sealed to prevent rodents, insects or water-carried contaminants from entering the well. Insect or rodent access to a well can cause serious contamination from feces and carcasses. Not only could the well become inoperative, the whole aquifer can be put at risk.

Prevent corrosion. Surrounding grades and surfaces must prevent runoff from entering into the well or around the casing to prevent chemical and microbial contamination.

Consider pulling pipes and pumps from wells to avoid serious corrosion problems and to facilitate bringing wells back into production.

Protect the aquifer. In permanent decommission, pull pipes and pumps from wells. Seal wells and cap the casing below ground to adequately protect the aquifer. Details of procedures and standards are given in Alberta's *Water Act*.

For more information on well management, see the *Water Wells that Last* series of publications and videos available from AAFRD.

3.5.8 Weed control

Continually monitor and control weeds around the entire feedlot area, including the lot surface, debris basins, runoff control

facilities, etc. Weeds can spread to nearby fields, encourage insect breeding and leave a poor impression for passersby.

3.5.9 Petroleum storage and spills

Remove petroleum products. Use or remove petroleum products, such as stored gasoline, diesel, greases and oils. Spills and leakage of these products could seriously harm the environment, pose a risk to human and animal health, and are a fire hazard. Ingestion of even small amounts of bituminous material by livestock can cause illness or death.

Remove fuel tanks. For a long-term shutdown, remove fuel tanks from the site. Use elsewhere or dispose of at a landfill site.

Reclaim soil. Areas of soil contaminated with oil or fuel (used oil spread, machine parking area, shop floors) can be reclaimed by the methods used in the oil industry. The range of alternatives includes land spreading of contaminated soil, bio-remediation on-site, hauling to a secure and capped landfill (Class 1), and hauling and decontamination at a hazardous waste facility. The choice will depend on the contaminants and the amount of material. For more information, contact the regional office of Alberta Environment.

3.5.10 Compacted areas

Permanent decommission and conversion to cropland may require the reclamation of highly compacted areas. Roads and parking lots may have to be deep ripped to 60 centimetres (25 inches) or deep plowed before crops can

be grown adequately. Consider deep ripping other high/heavy traffic areas, such as the silage pit and dry feed staging area. For best results, deep rip when the soil is dry.

3.5.11 Drainage alleys

If the feedlot area is converted to annual crops, seed the drainage alleys to perennial forages and treat like any other grassed waterway to prevent soil erosion. For more

information on grassed waterways, see *Watercourse Improvement and Gully Restoration* (Agdex FS573-5), available from AAFRD.

3.5.12 Landfilling debris

Permanent shutdown of a feedlot requires the removal of penning materials, bunks and buildings. While some materials can be salvaged, large amounts of material are waste and should be appropriately disposed of at a landfill. Burying of demolition debris on the feedlot site is not permitted under Alberta's *Environmental Protection and Enhancement Act*.

Contact the local landfill sites (Class 1 or 2) for site-specific details on times and regulations about demolition debris. For further details on landfills, contact the regional Alberta Environment office.

Contact the municipal development authority to determine whether a demolition permit is required. Since demolition is considered a change in land use, some jurisdictions may require a permit.

3.5.13 Medical supplies, sharps and pesticides

Remove medical waste and pesticides (see Section 8).

Many landfill sites have special areas and procedures for handling pesticides. Contact the local landfill for details.

3.5.14 Permit requirements

Permanent decommission of a feedlot requires notification of the permitting authority to terminate any conditions of the operation and to comply with any specific decommission requirements of that agency.

For a change of land use or feedlot demolition, contact the approval officer at the NRCB. To close water wells or change the

water use, contact the regional office of Alberta Environment. To turn off utilities, contact the local suppliers of gas, electricity, etc.

For shutdowns of more than six months, discuss the permits and requirements with the municipality and the relevant authority for any existing permits.

3.6 General Farm Aesthetics

Often it is said that, regardless of actual physical measurements of odour-causing chemical compounds, a neat and tidy livestock operation is less odorous than a livestock operation that is less aesthetically pleasing.

The design and construction of a feedlot site can be enhanced to provide a more pleasing appearance. Trees or constructed shelterbelts

provide visual screening, in addition to wind protection, dust and odour control. Vegetative strips and buffers provide a pleasing appearance and help filter runoff.

The key is to incorporate some thinking about overall public perception when planning the feedlot, then managing to provide overall site hygiene and a positive appearance.

3.7 References

References available through AAFRD:

- Canadian Council of Ministers of Environment. www.mbnet.mb.ccme.
- *Dugouts for Farm Water Supplies* – Agdex 716.B30.
- *Dugout Maintenance* – Agdex 716. B31.
- *Dugout Aeration With Compressed Air* – Agdex 716. B36.
- *Float Suspended Intake* – Agdex 716.B34.
- *Hydrated Lime for Algae Control in Dugouts* – Agdex 716.B37.
- *Seepage Control in Dugouts* – Agdex 716.B32.
- *Water Analysis Interpretation* (Agdex 400/716-2). Provides a summary of water quality information for livestock.
- *Water Wells that Last for Generations*. An 87 page manual and workbook on water wells.

Additional references are available through AAFC or PFRA at www.agr.gc.ca/pfra.



3.0

4.0 MANURE STORAGE, HANDLING AND TRANSPORTATION

Planning, siting, maintaining, and handling manure is about managing environmental risk. Under the *Agricultural Operation Practices Act* (AOPA), which came into effect in January 2002 for new and expanding feedlot operations, a professional engineer must design and

develop the plans for the system, stamp and sign the plans, and certify that the design and the plan meet AOPA requirements for manure storage and surface water runoff control systems, including catch basins.

4.1 Manure: A Valuable Resource

The production of beef in feedlots produces large volumes of manure and manure-enriched liquids (runoff). Manure is a valuable by-product of beef production. However, to avoid pollution problems, a well-planned manure storage and runoff control system is required.

This section deals with the quantity of manure and volume of runoff produced from beef cattle, planning and maintaining manure storage facilities, including runoff control and collection, transportation of manure, composting of manure and fly control.

4.1.1 Manure quality and quantity

Feedlot manure quality is variable (Section 5.1):

- Manure is composed of bedding materials, feces, and urine.
- Nutrient composition is influenced by diet, bedding type, management, animal characteristics, and weather.

Feedlot manure quantity is also variable:

- Approximately 19 to 26 kg of fresh manure are produced per day per 450 kg of beef animal.
- Bedding adds 1 to 2 kg per day per animal.
- Estimated annual manure production is about 2.16 tonnes (at 50 percent moisture content) per finishing animal.

4.1.2 Feedlot runoff volume

A feedlot surface consists of a compacted soil manure layer, a gleyed layer and a manure pack or cover.

- Manure pack or cover absorbs moisture from precipitation and holds a portion of that moisture; the remainder is released in runoff and evaporation. These runoff yields have been reported to range from 15 to 53 percent of precipitation amounts.
- Actual amounts of runoff depends on storm intensity and duration, pen slope, manure pack condition, and stocking density.

- The gleyed layer and the soil-manure layer limit water movement downward.
- Removing accumulated snow and some of the manure pack in the late winter reduces snowmelt runoff, which leaves the pens cleaner and drier for the animals.
- Volumes for catch basin design are given in Schedule 2 of AOPA.



4.1.3 Runoff nutrient content

During the process of runoff, water absorbs chemicals from the manure pack and transports sediment from the manure pack by erosion. The nutrient and salt content of the runoff

depends on the amount of time the water is in contact with the manure pack. Typical values are given in Table 4.1.

Figure 4.1 Feedlot Runoff*

	Liquid (% wet basis)	Sludge (% wet basis)	Pounds/ 1000 gallons
Total solids	0.30	17.20	-----
Electrical conductivity	3.2 to 8.6**	-----	-----
Total nitrogen	0.02	0.62	61.9
NH ₄ -nitrogen	0.0179	-----	-----
Total phosphorus	-----	0.21	21.0
Potassium	0.09	0.17	17.0
Chemical oxygen demand	0.14	7.74	

* Part 651, Agricultural Waste Management Field Handbook, Chapter 4, Agricultural Waste Characteristics, Table 4-10, 1996
 ** Kennedy et al, 1999

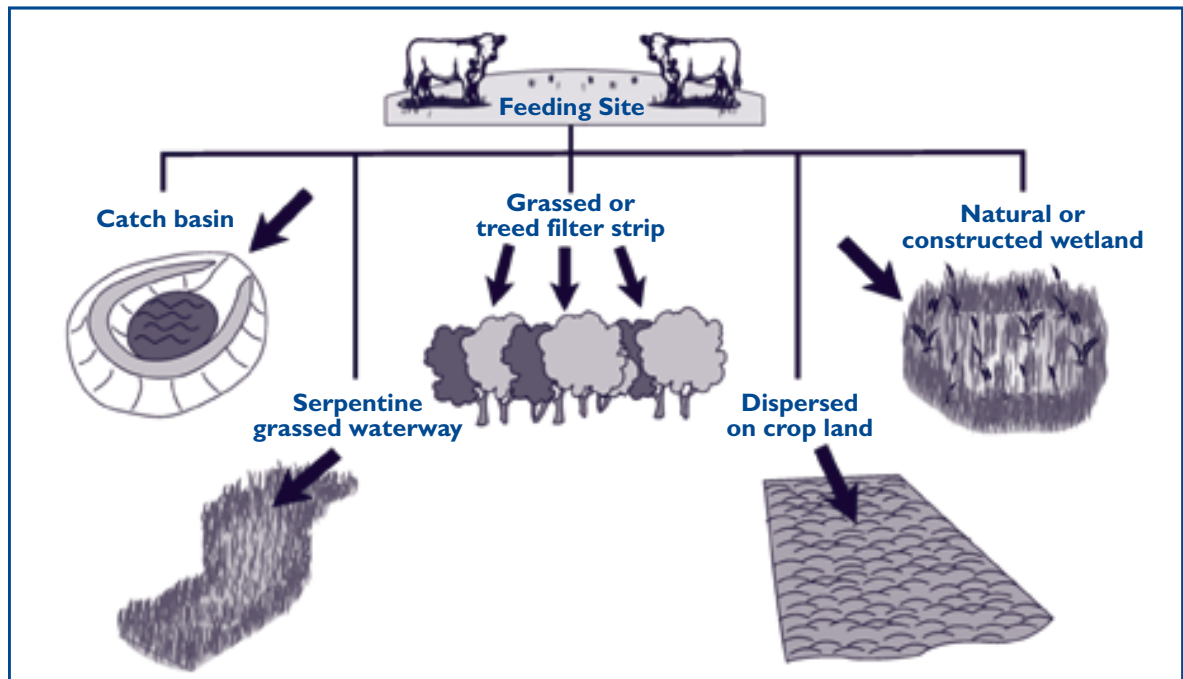
4.1.4 Feedlot runoff control

Pen runoff and run-on that travels from outside the feedlot and through the pens, erodes and carries material away from the manure pack.

- This material is a mixture of soil, hair, fine bedding materials, fecal particles, grain hulls and undigested grain.

- Steep slopes in the pens and drains, as well as intense rainfall events, tend to carry this material and cause high sediment loading in the runoff.
- Material settles out as the water slows down.

Figure 4.2 Methods Used to Manage Contaminated Runoff



Reference: Alberta Feedlot Management Guide

Components of a feedlot runoff control/ collection system:

- Diversion of up-slope run-on.
 - Keep clean water clean by diverting it around the feedlot.
 - Minimize the amount of runoff from the feedlot, and therefore reduce the size of the catch basin required (also reduces emptying costs).
 - Divert up-slope run-on by using ditches, berms or dikes.
- Pen and roadway drainage.
 - Pen slopes of 2 to 4 percent from pen front (feed bunk) to back are ideal; slopes of 1 to 6 percent are acceptable (economics of earth moving will determine exact pen slope).
 - Pens constructed on soils with higher clay content drain better.
 - Removing manure packs improves dryness of pens for animal comfort.
 - Pen length and pen slope are interrelated (see Section 4.3.2, Table 4.2). As pen slope increases, pen length should be decreased to minimize erosion.
- Drains to settling area.
 - Runoff leaving the back of the pens needs to be collected and directed to the settling area by using a drainage channel.
 - Drains should slope 0.5 to 2 percent (maximum).
 - Drains need a wide, flat bottom for removing some solids buildup, for mowing grass and weeds and perhaps snow accumulations.
- Settling area.
 - Removes solids being carried in the runoff before the runoff enters the catch basin.
 - Settling area is a large, shallow, flat-bottomed area with a firm base to allow removal of solids with a front-end loader.
 - Sizing the settling area depends on rainfall intensity and retention time. Typically, for a 1 in 30 year, 24 hour rainfall event of 95 millimetres and a retention time of 20 minutes, the surface area of the settling area would be about 0.3 percent of the area being drained, and the depth of the settling basin would be about 0.2 percent of the surface area. (For details on designing settlement basins, see pages 3I1:30 and 3I1:31 in the *Alberta Feedlot Management Guide*.)
- Holding pond or catch basin design (AOPA). Contact NRCB for further details.
 - Catch basins must be designed by a professional engineer, and the plans and construction must meet AOPA standards and include (but not necessarily be limited to):
 - (i) Proper siting in relation to neighbours.
 - (ii) Run-on and runoff water control system.
 - (iii) Location with respect to springs and water wells (greater than 100 metres) and open water bodies (greater than 30 metres). Some exceptions may apply.
 - (iv) Location with respect to 1 in 25 year maximum flood levels (must be 1 metre above this level).
 - (v) Must have a designed liner system:
 - The liner must lie below the bottom of the facility and above the uppermost aquifer of the site.
 - If the liner is manufactured, whether of natural or synthetic materials, the bottom of the liner must be not less than one metre above the water table of the site at the time of construction.
 - If the liner is made of non-compacted naturally occurring material, the top of the liner must not be less than one metre above the water table of the site at the time of construction.
 - If the liner is made of non-compacted naturally occurring material, it must have not less than five metres of naturally occurring material with a hydraulic conductivity of not more than 1×10^{-6} centimetres per second.
 - Bottom of liner must not be less than one metre above the top of an aquifer.
 - Alternative liner systems that are constructed and maintained to provide the same or greater protection may be considered by the AOPA Board.
 - (vi) Must be designed and have a storage capacity to accommodate the runoff from a 1 in 30 year, 24 hour precipitation event (AOPA, Schedule 2).
 - (vii) Must have a freeboard of not less than 0.5 metres when the basin is filled to capacity.
 - (viii) Must have a marker clearly visible at all times that indicates when the catch basin is filled to capacity.



It is recommended to use buildings, topography, trees or fences to make these catch basins more visually acceptable. If, under natural drainage conditions, the runoff from the feeding area does not leave the property, a catch basin might not be necessary.

Runoff utilization (AOPA):

- The catch basin must be emptied onto cropland when full (or nearly full) to ensure adequate catchment volume for the next runoff event.

- It must be emptied in such a way that the catch basin contents do not create an environmental risk by leaving the land to which they are applied or by entering an open body of water or by becoming return flow.
- Must not be applied on a crop grown for human consumption, which is intended to be eaten uncooked.

4.1.5 Maintenance and monitoring of catch basins

- Visually inspect for:
 - Liquid levels.
 - Wave damage to liner.
 - Erosion damage at entry and at pumping points.
 - Cracking or slumping of the liner.
- Sampling wells may be required in some situations to monitor for changes in ground water conditions.
 - Seepage on the outside of the berm.
 - Rodents and/or trees. Remove if present.

4.1.6 Safety

- Manure storages, catch basins and dugouts must be secure from access by animals or unauthorized persons.
- A dock or ramp is necessary for safe access when emptying or entering the storage for maintenance.
- A clearly visible sign should be erected at the entrance, warning of the nature and danger of the facility.



4.2 Alternatives to Catch Basins

Catch basins may not be necessary in all cases. Alternatives include diversion to

cropped areas, vegetative filter strips and constructed wetlands.

4.2.1 Vegetative filter strips

Vegetative filter strips are widths or lengths of vegetation that act as a filter to trap and utilize sediments and nutrients from runoff.

Vegetative filter strips may be sufficient to minimize runoff pollution from some livestock operations, such as smaller backgrounding feedlots, small finishing lots, winter feeding sites, calving pens, manure stockpile sites, and manure spreading on cultivated fields.

Factors influencing the effectiveness of vegetative filters are:

- Drainage area up-slope from the operation.
 - The amount and form of precipitation (snow, rain, or both).
 - Slope of the operation site and whether the natural topography lends itself to sheet or channel runoff.
- Vegetation type (summer fallow, stubble, grass or trees, etc.).
 - Soil type (sandy, loam, or clay, etc.).

For example, frozen ground in the spring, combined with a packed non-vegetative thatch, will not filter contaminants as effectively as land in the summer.

To date, there is minimal definitive research that verifies how to design a vegetative filter strip based on the above variables. However, the limited research that has been done seems to indicate that a 30 metre wide separation from a watercourse for 1 to 4 percent slopes, 60 metres for 4 to 6 percent slopes, and 90 metres for 6 to 12 percent slopes is adequate. Further research is required to determine more specific design details.

4.2.2 Wetlands

Wetlands are either naturally occurring sloughs or lowlands, or they are constructed wetlands that are designed and landscaped. In some instances, they might be used to collect and treat contaminated runoff from livestock operations. The nutrients and contaminants from the runoff are absorbed and utilized by the bullrushes, sedges, and other marsh-type vegetation growing in the wetland area.

Wetlands must be properly evaluated and designed to ensure adequate retention and filtering. As a minimum, these lowlands or wetlands must be entirely contained on the producer's property, and soil conditions must be tested to ensure there is no leaching into groundwater.

Figure 4.3



Wetlands can be used to collect and treat contaminated runoff from livestock operations.



4.3 Feedlot Pen Surface Management

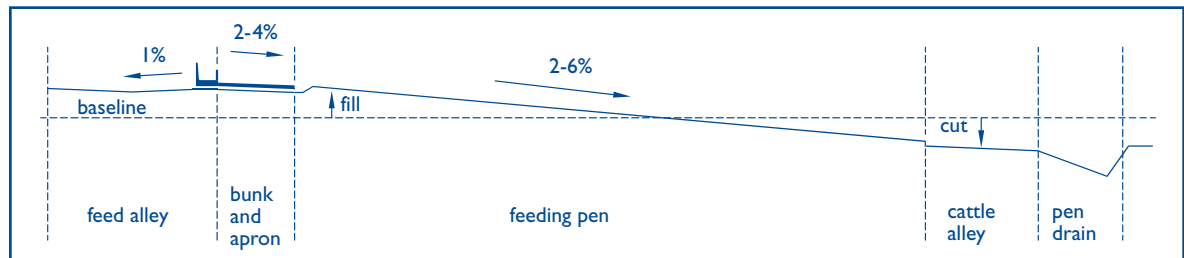
4.3.1 Initial pen surface

- Surface is created by removing topsoil and landscaping subsoil to form a uniform, sloped surface that drains water.
- Surface must be smooth and compacted.
- Best subsoil is silt or clay because it compacts and seals well.
- Pen surface slopes from 1 to 6 percent are recommended (ideal is 2 to 4 percent).
- Maximum pen length is about 70 metres.
- As pen slope increases, pen length should be shortened to reduce erosion.

Figure 4.4
Recommended Pen Length Based on Pen Slope

Pen Slope (%)	Pen Length (metres)
2	70
3	65
4	60
5	55
6	50

Figure 4.5 Pen Slope

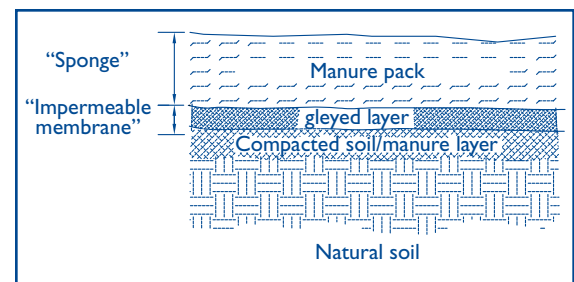


Reference: Alberta Feedlot Management Guide

4.3.2 Pen surface development

- With the addition of cattle, manure and urine will accumulate on the pen surface.
- Action of cattle hooves mixes manure and urine into the soil and compacts the resulting mixture.
- Chemicals in manure and urine change the soil's chemical properties (e.g., high sodium levels tend to disperse soil particles and reduce infiltration of water).
- Physical compaction results in anaerobic (low oxygen) conditions at the bottom of the manure pack, which results in the formation of organic gels, or slimes; these further reduce the infiltration rate.
- End result is the development of four distinct layers. See Figure 4.6.
 - (i) Manure pack:
 - Consists of accumulated manure and bedding.
 - Acts as a giant sponge, absorbing rain and snowmelt.

Figure 4.6
Development of Four Distinct Layers



Reference: Alberta Feedlot Management Guide

- When saturation is reached, runoff occurs (may absorb up to 25 mm of precipitation).
- Depressions from cattle hooves hold water, increasing storage capacity.
- During dry spells, water held in the manure pack evaporates.

- (ii) Gleyed layer:
 - A layer of transformed organic matter, gels and slimes.
 - Develops under conditions of poor drainage and a lack of oxygen.
 - Relatively impervious and restricts movement of water, nutrients and salts into layers below.
 - Five to 10 centimetres thick.
 - Slippery (slimy) when wet and if exposed to air, has an offensive odour.
 - Felt-like texture when moist; charcoal texture and colour when dry.
 - Limits leaching of nitrogen compounds. If removed during scraping, nutrients will begin leaching.
 - Removing cattle also allows the breakdown of this impervious layer.
- (iii) Soil-manure layer:
 - Made up of soil mixed with organic matter from manure.
 - About 15 centimetres thick.
- (iv) Mineral soil:
 - Loam or clay based soils compact and seal well, and have a low infiltration rate.
 - Sandy or gravel based soils do not seal or compact adequately for the development of a good feedlot surface.

4.3.3 Floor pen requirements during development

Under AOPA, the floor of a feedlot pen is considered a “manure collection area.” As such, there are design standards related to flooded areas and water table protection.

Flooded areas:

- The 1:25 year maximum flood level must not be less than one metre below any part of the facility where run-on can come into contact with stored manure.
- If the 1:25 year maximum flood cannot be determined, the pen floor must not be less than one metre below any part of the facility where run-on from the highest known flood level can come into contact with stored manure.
- The feedlot must include erosion control measures that can protect the facility from erosion, runoff, run-on and flooding.

Pen liner requirements for water table protection (similar to requirements for catch basins):

- Liner must lie below the bottom of the facility and above the uppermost aquifer of the site.
- If the liner is manufactured, whether of natural or synthetic materials, the bottom of the liner must be not less than one metre above the water table of the site at the time of construction.

- If the liner is made of non-compacted naturally occurring material, the top of the liner must not be less than one metre above the water table of the site at the time of construction.
- If the liner is made of non-compacted naturally occurring material, it must have not less than two metres of naturally occurring material with a hydraulic conductivity of not more than 1×10^{-6} per second.
- Bottom of liner must not be less than one metre above the top of an aquifer.
- If the liner is made of compacted naturally occurring material:
 - The liner must not be less than one metre thick when measured perpendicular to the liner’s surface.
 - The bottom of the liner must not be less than one metre above the top of an aquifer.
 - The compacted naturally occurring material must give the same or greater protection than that provided with non-compacted naturally occurring material.

The AOPA Board may consider alternate liner systems that are constructed and maintained to provide the same or greater protection than that provided above.



4.3.4 Maintaining the pen surface

Pen surface maintenance has benefits for livestock health, economics and environmental quality. A dusty feedlot can cause respiratory problems in animals and can be a nuisance to neighbours. Animals wading through a wet, muddy surface do not gain efficiently and can suffer up to a 25 percent loss in performance. Accumulations of manure and soil (tag) on the animal's hide reduce the value of the hide, increase processing costs, affect food safety and lower the overall profit from the animal.

The three key practices for pen surface maintenance are:

- Scrape the pen surface regularly.
 - Gather and pile the manure pack whenever more than 2.5 centimetres of loose manure and bedding accumulates.
 - Use a box-scraper or elevating scraper to minimize damage to the gleyed layer (a scraper will ride on the gleyed layer without gouging or breaking through it).
- Maintain moist conditions (see Section 7).
 - Dust and odour problems are minimized if the layer of loose manure is at 25 percent to 45 percent moisture content.
 - About eight millimetres of moisture minimizes ammonia losses to the atmosphere.

Figure 4.7



Use a scraper to maintain the feedlot pen surface.

- Increasing or decreasing animal numbers in a pen may help to maintain this moisture level. For example, increasing animal numbers in warm, dry periods increases the amount of urine, which may help to keep the pen surface damp.
- If sufficient water is available, sprinkler systems can also be used for dust control, but this may increase odour if not properly managed.
- Fill in low spots.
 - Ideal fill is clay or silty soil.
 - Maintain a smooth, even pen surface and prevent ponding of water.

4.4 Short-term Solid Manure Storage

Short-term solid manure storage is defined as manure storage for no more than six months over a period of three years. In feedlots, it is not recommended that manure be stored in piles outside of the feedlot facility for extended periods of time, unless this is part of a composting operation. Follow the guidelines from Alberta Environment for composting. If it is necessary to temporarily store manure in piles after cleaning pens prior to land application, do so only for a very short period of time to reduce odour and fly nuisance complaints from neighbours and to reduce the risk of surface and groundwater contamination.

Under AOPA standards, a short-term manure storage site:

- Must not be within 150 metres from the nearest residence that is not owned or under the control of the feedlot.
- Must be located at least one metre above the water table.

As well, there must be controls in place to divert surface run-on and manage runoff from the storage site so that it doesn't enter open bodies of water.

4.5 Composting

Cattle produce solid manure that is high in nitrogen and nitrogen products. Natural bio-oxidation processes can be used to reduce the volume of the manure. The process can be as simple as mounding manure and bedding in the pen and turning it two or three times to produce a high quality, marketable product that can be removed to a planned and

managed site. It is important to view the material as a resource, not as waste.

In Alberta there are requirements for a composting operation. These requirements are found in the *Code of Practice for Compost Facilities* under *Waste Control Regulation A.R. 192/96*, and are developed and administered by Alberta Environment.

4.5.1 Definitions

Compost. Compost is a stabilized organic product produced by the composting process. It is loose, friable, dark in colour and has an earthy odour. Compost is beneficial to plant growth and is sanitized to a degree, to protect human health.

Composting. Composting is a natural biological oxidation process that decomposes and stabilizes organic material into a humus-like

material. During the process, which is aerobic, high temperatures destroy weed seeds and harmful micro-organisms, such as *E. coli* O157:H7, *Salmonella*, *Giardia* and *Cryptosporidia*. The composting process can be enhanced and managed by mixing organic materials and other ingredients in the proper proportions to enhance microbial activity. Composting is a natural, but slow process.

4.5.2 Properties of compost

As a product there are many characteristics of compost to consider. Maturity of the product is a measure of the completeness of the composting process. Basically, compost is mature when it has aged at least 21 days after the end of the thermophilic stage (temperatures of 40–70 C) of the composting process. Another measure of maturity is when 90 percent of cress and radish seeds germinate in the compost.

Foreign matter. Compost must not contain excessive foreign matter. Foreign matter is defined as anything larger than two millimetres in dimension and caused by human activity. There should not be any sharp objects in the compost.

Trace elements. Trace elements are chemicals present in small quantities. Examples are heavy metals, although these are more of a problem in human sewage than livestock manure. There are regulations that limit the level of trace elements in compost.

Pathogens. Composting reduces the level of pathogenic micro-organisms by heating. Composting must be closely supervised to ensure that all parts of the material are exposed to temperatures in excess of 55 C for a specified time.

Other characteristics. Other characteristics of compost include organic matter content, water content, pH, electrical conductivity, quantities of nitrogen, phosphorus and potash in the product, as well as the water-holding capacity.

These and other factors determine the characteristics of compost. There are legislative requirements to be considered when constructing and operating a composting facility. Legislative requirements also apply to the sale of compost. Contact Alberta Environmental Protection for further information.



4.5.3 Process

Composting is a relatively simple biological process that requires:

- A source of energy (carbon).
- Nutrients (nitrogen in its various forms), moisture, oxygen to maintain an aerobic environment and a pH of 6 to 8.
- The absence of substances toxic to microbial growth.

The process of composting gives off water vapour, heat and carbon dioxide. Finished compost volume is about 50 to 75 percent of the volume of the raw material.

A composting “mix” or recipe is a mixture of manure, bulking agents and amendments. A **bulking agent** is a substance used to make the material self-supporting and to increase air movement in the pile. For example, shredded tires are used as a bulking agent, but are removed when the composting process is completed. An **amendment** is a material added to the mix to change pH, moisture content and to add nutrients. Some examples of amendments are shredded paper, grass cuttings, sawdust, crop residues, and municipal solid waste. In some cases, a product such as wood chips is added to function both as a bulking agent and an amendment. In feedlots, straw or wood chips are often used as bedding material, and this is often sufficient to achieve proper composting.

The design of the composting mix must consider the manure being composted, the amendments and the bulking agents. The composting process is most rapid when the correct mix is used and optimum conditions for biological activity are maintained. These conditions are:

C:N (carbon:nitrogen) ratio. A balance between carbon and nitrogen is the most critical factor in the composting process. Ideally the C:N ratio must be between 20:1 and 40:1, but can work as low as 10:1 or 15:1. If the C:N ratio is low, then ammonia is volatilized (nitrogen lost in air); if it is high, composting time increases because nitrogen is in short supply.

Moisture content. Water is necessary for all biological processes. The ideal moisture

content for composting is 40 to 60 percent. Below 40 percent, the rate of decomposition is slow; above 60 to 65 percent, the process becomes anaerobic and produces odour. Frequent turning during hot summer weather causes moisture losses, which may inhibit the composting process.

Oxygen concentrations. To maintain aerobic conditions in the pile, oxygen concentrations must be greater than five percent. This is accomplished by turning the pile or by blowing air through it.

pH. An optimum pH range for composting is between 6.5 and 8. Both bacteria and fungi are active in the composting process. Bacteria grow in the pH 6.0–7.5 range. Fungi grow at pH 5.5 to 8. Generally pH will vary throughout the pile and during the different phases of composting. Some control of composting pH can be achieved by adjusting the mix with acidic and alkaline materials.

Temperature. Composting produces heat and increases the temperature of the pile. With optimum conditions, the temperature of the interior of the pile will reach 40–70 C, but the exterior of the pile will be cooler. If temperatures are maintained at high levels for an extended time period, pathogens, weed seeds and insects will be destroyed. The pile must be turned regularly to ensure that all parts of the material reach and maintain those high temperatures.

Toxic substances. Substances that are toxic to microbial growth will slow down or inhibit the composting process. Examples of toxic substances are high levels of salts and antibiotic residues. The levels of toxic substances in the mix must be low so that the composting process is not inhibited.

Once the materials are mixed and piled, the composting process begins. It will continue over a period of several weeks until the process is complete. After the initial thermophilic phase of composting, there is a “curing” phase that can take several weeks or months to produce mature compost.

4.5.4 Methods

There are three basic methods of composting:

- Static pile.
- Windrow.
- Vessel.

Static pile. The pile method or aerated static pile, consists of placing the composting mix in piles over an air source. Air is either blown or sucked through the piles. Alternately, piles may be built on open-ended perforated pipes. Air enters the piles periodically and moves through the perforations into the pile in a “chimney effect.” Airflow is controlled based on the temperature of the pile. The pile is covered with a layer of compost or other material, so that all of the composting material reaches temperatures high enough to reduce pathogens.

Advantages of this system of composting are:

- Turning equipment is not needed.
- Good pathogen destruction.
- Good odour control.
- Good product stabilization.

Disadvantages of the system are:

- Not space efficient.
- Affected by climate.
- Difficult to work around the piping and ducting that is used to move air.
- Costly to operate and maintain the blowers.
- Too unwieldy for large volumes of manure

Windrow. The windrow method uses windrows of composting material. The windrow is a long triangular pile with a width about twice its height. Width is usually four to five metres and height is 1.5 to 2.5 metres. This cross-section is large enough to maintain heat

in the composting process and small enough for aeration. To maintain aeration, the pile must be turned periodically. Minimum time between turnings is two to five days, depending on composting mix, weather and windrow size.

Turning can be done with specialized windrow turning equipment or a front-end loader. A front-end loader may be the most efficient for operations that produce less than 2,295 to 3,060 cubic metres of compost per year.

Advantages of the windrow method include:

- Rapid product drying under warm temperatures.
- Drier product.
- Handles large volumes of material.
- Produces a stable product.
- Relatively low capital cost.

Disadvantages of the windrow method include:

- Requires large areas.
- High operational costs.
- Releases odour.
- May require large volumes of bulking agent.
- Weather dependent.

In-pen pile. This is a variation of the windrow method. Manure and loose materials are regularly scraped from the pen surface and placed in a pile. Periodically, about three times, the pile is turned before the manure is hauled out of the pen. The turning incorporates oxygen into the pile and starts a decomposition process. This process causes some decomposition and a reduction in the volume of material hauled out of the pen. This process is managed between regular pen cleanings.

Figure 4.8



Windrows of composting material.

Photo credit: Dr. Frank Lamey, Lethbridge Research Centre

Vessel. In-vessel composting is a controlled composting process using a container or reactor. One type of vessel composting uses multiple concrete channels up to several hundred metres long. Air tubes are placed under the channels to incorporate air into the composting material. Temperature and/or time controlled fans are attached to the tubes. Amount of airflow along the channel varies depending on the stage of the composting process. Material for composting is placed in one end of the channel and turned regularly. The action of turning moves the material

towards the other end, where it is eventually removed as finished compost.

Advantages:

- Can be covered for weather protection and odour control.
- Space efficient.
- Can be designed as a continuous process.

Disadvantages:

- Highly mechanized and capital intensive.
- Requires careful management.
- Less flexible than other methods.

4.5.5 Regulations and standards

In Alberta, there are requirements for a composting operation. These requirements are found in the *Code of Practice for Compost Facilities* under *Waste Control Regulation A.R.192/9*, developed and administered by Alberta Environment. Composting facilities are divided into two classes: those that accept less than 20,000 tonnes of material per year and those that accept more than 20,000 tonnes of material per year. The smaller operations are required to register and the larger operations are required to have an approval.

A number of site and operational requirements are contained in the *Code of Practice for Compost Facilities*. Some of these requirements are:

- Run-on control.
- Leachate and runoff control.
- Odour control.
- Seepage control.
- A stated capacity for storage of feedstock and compost.
- Minimum escape of materials from the site.
- Groundwater monitoring.
- Operating requirements, such as time and temperature minimums for the composting materials.

Contact Alberta Environment for further information and to get a copy of the *Code of Practice for Compost Facilities*.

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Northeast Boreal & Parkland Regions
Regional Director
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Edmonton, AB T5K 2J6
Phone: (780) 427-9562
Fax: (780) 422-5120

Alberta Environmental Protection
Northwest Boreal and Northern East
Slopes Regions
Regional Director
Provincial Building
203, 111 – 54 Street
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Phone: (780) 723-8395
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Alberta Environmental Protection
Southern East Slopes and Prairie Regions
Regional Director
201 Deerfoot Square
2938 – 11 Street N.E.
Calgary, AB T2E 7L7
Phone: (403) 297-7605
Fax: (403) 297-5944

4.6 Transportation of Manure

Moving feedlot manure from the pen to the field is an important component of a manure management system. Hauling from pen to field requires not only an economically sound system, but one that is also safe and responsible. Beware of manure spills on the road as these can be in violation of the *Transportation Act* and *Alberta Environment Protection Act*.

It is important to recognize the nuisance risks associated with manure transportation. These include dust, spillage and physical impact on roads.

At a feedlot, manure hauling traffic can be very intense for short periods of time. Traffic on gravel roads during dry, windy periods can result in significant dust generation. If these conditions exist in sensitive areas, dust suppression (Section 7), or detouring may be necessary.

Although manure is a biodegradable product, direct spillage from manure trucks

must be kept to a minimum. Manure haulers need to be aware of the risks when hauling on roads. Whether it is a wet or dry product, spillage may occur through seepage, overloading or blowing. Whatever the case, appropriate management and equipment is required to keep the roads and ditches free from manure spillage. In the event of excessive spillage, cleanup measures, such as sweeping, will be required.

The intensity of traffic during manure hauling may have a significant impact on lower grade roads. Many feedlots have entered into road-use agreements with their local municipalities, which clearly define responsibilities. These same road use agreements may also include responsibilities as they relate to dust generation and spillage.

Transporting manure is an important component of a good nutrient management plan. Safe and efficient manure hauling is possible when these factors are considered.

4.7 Fly Management for Feedlots

4.7.1 Fly management

Integrated pest management (IPM) is the integration of chemical, biological and cultural control methods to reduce pest populations below an economic threshold. Effective fly management requires:

- Monitoring as a basis for control decisions.
- Application of cultural control to reduce the frequency of population outbreaks.
- Applications of chemical control for immediate relief of fly populations.

Two species of flies are significant pests in Alberta feedlots – the house fly, *Musca domestica*, and the stable fly, *Stomoxys calcitrans*. The biology and life cycle of the two are similar, but there are differences in feeding habits and habitat selection. Both species have adult, egg, larval and pupal stages. The larval stages of both species develop in moist, rotting organic matter.

House fly. Adults average 10 mm long, are dark grey in colour, with four longitudinal dark stripes on the thorax and yellowish sides on the abdomen. The wings are held partially open at rest, forming a V-shape. The mouth parts are held beneath the head and are not visible from above.



Photo credit: Dr. Tim Lysyk, Lethbridge Research Centre

House flies do not feed directly on animals; they feed on liquid food. Preferred resting sites are indoors. House flies annoy workers and can reduce worker efficiency. In addition, the adults are active fliers and can travel distances of one to three kilometres into neighbouring communities where they cause public health concerns. The adults regurgitate while feeding and can leave unsightly vomit and fecal spots on resting areas. This behavior, their association with manure and feces and their tendency to enter homes make them efficient vectors of disease. They are capable of mechanically transmitting bacteria such as *E. coli* and *Salmonella*. Outdoor populations fluctuate, but peak in midsummer. Indoor populations may be present all year.



Stable fly. Adults average eight millimetres long and are grey in colour, with four longitudinal dark stripes on the thorax and several dark spots on the top of the abdomen. The wings are held partially open at rest, forming a V-shape. The mouth parts are visibly extended forward from the head as a long, slender, piercing proboscis.



Photo credit: Dr. Tim Lysyk, Lethbridge Research Centre

Stable flies feed intermittently on cattle blood by cutting the skin with a sharp

proboscis (mouth part). The bite is painful and can cause severe irritation to animals. Both sexes feed on blood. Stable fly attacks often cause behavioral changes in cattle, causing them to twitch, stamp their feet and bunch. Since stable flies feed during the warmest part of the day, this may cause problems with heat stress. Additionally, stable flies cause reduced weight gain and reduced feed conversion efficiency.

The adults rest on sheltered vertical surfaces outdoors. Flies are active from May through October. Populations are at low levels early in the year, peak in August, and may persist until after frost. Attacks are most severe during July and August.

4.7.2 Monitoring

Monitoring fly populations is required to determine pest levels, to determine whether control efforts are required and to evaluate the effectiveness of control measures.

House fly

- **Spot cards.** The simplest monitoring method is to place 8 x 13 centimetre size white index cards on resting sites and count the number of fecal and vomit spots that accumulate weekly. Ten cards should be placed on resting sites and held in position with thumbtacks or tape. The average number of spots per card per week is used as an estimate of fly density. Usually, 100 spots per card per week is an indication of high populations that require treatment, although this level will vary from site to site. Cards can be dated and used as a permanent record.
- **Baited jug-traps.** Use two-litre plastic pails with 3.5 centimetre holes cut in the sides near the top. The pails are hung from rafters indoors and are baited with 25 grams of house fly bait that includes a toxicant and chemical attractant specific for house flies. The number of flies captured per trap per unit time is used as a measure of fly density. A common treatment threshold is 300 flies per trap week. Six traps placed indoors can provide useful estimates of fly density.

Stable fly

On cattle, stable fly populations are best enumerated using visual counts of the number of flies per front leg. There are two ways this can be done. Counts should be made on a weekly basis to track population changes over time. Examine a minimum of ten animals. Count flies on sunny days when temperatures are greater than 15 C.

Number of flies per front leg. The number of flies per leg are counted by either viewing animals from the side or the front. In order to make valid comparisons, select a view and use it consistently. For a side view, count the flies on the outside of one front leg, from the hoof to the shoulder, and also on the inside of the other front leg. For the front view, count the number of flies visible on the front leg from the hoof to shoulder. This is easily done when animals are feeding. An average of about 5 flies per leg indicates that immediate treatment is necessary.

Proportion of infected legs. For a simpler method to determine if treatment is needed, simply record whether or not stable flies are present on the legs of 10 cattle (20 legs total). If greater than 50 percent of the legs are infested, consider chemical treatment.

4.7.3 Control measures

Cultural control. Cultural control, in the form of manure management, must be applied diligently to reduce larval developmental sites. Manure is managed to reduce moisture, eliminate pest developmental sites and enhance populations of natural enemies. Remove manure before peak fly abundance and spread to dry. This should be completed before the beginning of July.

Moisture control. Control sources of moisture to reduce the potential number of larval developmental sites. To control moisture:

- Repair leaking water bowls.
- Provide drainage and runoff channels.
- Place concrete aprons around feeders and water bowls.
- Enclose areas beneath feed bunks.
- If in heavy rainfall area, cover hay bales and store on a slope or pallet to prevent moisture from wetting the material in contact with the ground.
- Place concrete pads under fences to facilitate cleaning.

Eliminate developmental sites. Sanitation will eliminate developmental sites and reduce the breeding success of these flies. Remove manure and either store and compost or spread on fields. Major areas that should be targeted include the manure mounds within the lots, manure dispersed throughout the lot itself and indoor manure. Other sites include the margins of silage mounds and feed bunks where spilled feed collects, as well as the areas underneath fence lines.

Chemical control. Chemical insecticide applications can reduce fly populations. Use only insecticides registered for the specific application. This will be listed on the insecticide label. Insecticides for house and stable fly control can be applied as residual sprays on resting surfaces. Insecticides for stable fly control can be applied directly to animals in the form of sprays or aerosols; however, this tends to be less effective, since stable flies spend relatively little time on cattle. Chemical applications to manure and other larval developmental sites should be avoided. The developmental media, such as manure, interferes with insecticide contact.

The insecticides moisten the media and can inhibit the activity of naturally occurring biological control agents, such as predacious mites.

Surface and space applications. Surface and space applications can be used for control of both house and stable flies. The most effective method of chemical control for both species is to identify the preferred resting surfaces based on the presence of fly specks and apply residual, low pressure sprays to these areas, following the label directions. Since a large proportion of the fly population consists of larvae and pupae within the developmental media, applications may have to be reapplied at one to two week intervals to kill newly emerged adults.

Since house fly adults frequent indoor and confined areas, insecticidal mists can also be applied indoors according to label directions. It may be necessary to follow up with residual surface applications to kill newly emerged adults.

Adult house flies may also be controlled by applying scatter bait, a granular insecticide formulation. Apply scatter bait only in areas where contact with animals, pets and children is unlikely to occur.

Direct applications to animals. Direct application methods include sprays, which are concentrates mixed with water, and aerosols. Ready-to-use formulations in pressurized spray cans can also be used. These can provide limited control of stable flies as they feed on cattle, but have relatively short residual periods. For effective application, cattle must be held in a pen, chute or restricted area during application. All applications must be made in accordance with label directions.

Sprays will provide one to two-week residual control and can be applied at high or low pressures. Monitoring is essential to determine spray efficacy and whether reapplication is necessary.

Aerosols are applied as needed by spraying along the backline and upper body of the animal. These have a short residual effect (one to two days) and monitoring is essential to determine the need for reapplication.



4.7.4 Safety

Personal safety. To ensure personal safety during the application process:

- Follow label directions.
- Store insecticides in original containers in climate controlled, locked and ventilated areas.
- Wear protective clothing (gloves, respirator, suit) when handling insecticides.
- Wash with soap and water after handling insecticides.
- Dispose of empty pesticide containers according to label directions (Section 8).
- Do not contaminate lakes, streams, ponds, dugouts, or sources of drinking water.

Animal safety. To ensure safe insecticide application to animals:

- Follow label directions.
- Do not treat sick, emaciated or convalescent animals.
- Animals less than three months of age are generally not treated.
- Keep animals away from pesticide containers.
- Check the label for restrictions regarding concurrent applications with other pesticides or products.

Residue prevention. Improper use of pesticides can result in unacceptable levels of residue in meat and milk. To avoid residue contamination:

- Follow all label instructions.
- Apply insecticides only at the recommended doses.
- Follow the pre-slaughter withdrawal period, i.e., the time between insecticide application and slaughter.
- Do not contaminate animal feed or water with insecticides.
- Do not use insecticide-contaminated feed.
- Prevent animals from gaining access to treated grain or other feed.
- Check restrictions for lactating animals.

Resistance management. Improper use of insecticides can result in populations of pest flies developing resistance to insecticides. To delay or avoid resistance:

- Monitor pest populations and use insecticides only when needed. Do not apply routinely on a calendar day basis.
- Alternate application methods.
- Alternate chemical classes. For example, do not follow a pyrethroid with a pyrethroid. Follow a pyrethroid with an organophosphate.
- Use the recommended dose on the label.
- Do not spray before the onset of the fly season.

The following insecticides are listed in the Western Committee on Livestock Pests *“Recommendation for the Control of Arthropod Pests of Livestock and Poultry in Western Canada”*. This list of insecticides is subject to all changes in registration and labels authorized by the Pest Management Regulatory Agency, Health Canada. This list does not supersede or substitute the instructions on the label of a product. All label instructions must be followed carefully.

Figure 4.9

Fly Control Options

Baits – House Fly Only	Method	Cautions
<p>Chemical name: Azamethiphos 1% + 0.02% tricosene bait</p> <p>Trade name: Snip</p> <p>Chemical class: Organophosphate</p>	<ul style="list-style-type: none"> • Scatter bait at rate of 250 g/100 m² on fly feeding areas and places where flies congregate. • Scatter bait from a container to avoid handling bait. • Use gloves when handling product. • Scatter daily or as necessary. • Bait may also be applied in tamper-resistant containers hung in locations not accessible to children, pets, domestic animals or wildlife. 	<ul style="list-style-type: none"> • Do not use in dwellings. • Do not use in rooms where milk is processed, handled or stored. • Do not contaminate feed, water, food or litter. • Do not apply bait where can animals can pick it up or lick it. • Do not use on walkways used by animals. • Prevent accidental transfer by people or animals from treated areas to areas used by livestock. • Shoes should be cleaned to remove granules before leaving treated areas.
<p>Chemical name: Methomyl 1% + 0.025% tricosene bait</p> <p>Trade name: Premium Golden Malrin</p> <p>Chemical class: Carbamate</p>	<ul style="list-style-type: none"> • Scatter bait at rate of 250 g/100 m² on areas such as window sills and other areas where flies congregate. • Scatter daily or as necessary. • Paint 25 cm x 25 cm plywood boards with 50:50 mixture of syrup and carpenter glue. When surface is tacky, cover boards with bait granules. Place boards where flies congregate, out of reach of animals and children. 	<ul style="list-style-type: none"> • Do not use in dwellings. • Do not use in rooms where milk is processed, handled or stored. • Do not contaminate feed, water, food or litter.
<p>Chemical name: Naled dry bait</p> <p>Trade name: Dibrom</p> <p>Chemical class: Organophosphate</p>	<ul style="list-style-type: none"> • Mix 500 g granulated sugar with 2.5 ml 86% EC. Scatter bait at rate of 90 – 125 g/100 m² where flies congregate. 	<ul style="list-style-type: none"> • Store surplus bait in closed container. • Do not apply where animals or children can pick up bait.
<p>Chemical name: Naled wet bait</p> <p>Trade name: Dibrom</p> <p>Chemical class: Organophosphate</p>	<ul style="list-style-type: none"> • Mix 500 g sugar or 300 ml corn syrup or molasses with 10 L water and 15 ml 86% EC. Apply by sprinkler can to horizontal surfaces where flies congregate or feed. Use 5 – 15 L/100 m². • Repeat as necessary. 	<ul style="list-style-type: none"> • Prepare fresh bait each time. • Do not apply where animals or children can pick up bait
<p>Chemical name: Trichlorfon 1% bait</p> <p>Trade name: Dipterex</p> <p>Chemical class: Organophosphate</p>	<ul style="list-style-type: none"> • Scatter lightly in strips on floors, windowsills and other clean horizontal surfaces. Apply directly to garbage and manure where flies breed and gather. Use about 125 g/100 m². • Paint 25 cm x 25 cm plywood boards with 50:50 mixture of syrup and carpenter glue. When surface is tacky, cover boards with bait granules. Place boards where flies congregate, out of reach of animals and children. 	<ul style="list-style-type: none"> • Do not use in dwellings or milk processing rooms.



Figure 4.9 (continued)

Fly Control Options

Surface and Space Applications - House and Stable Fly	Method	Cautions
<p>Chemical name: Cyfluthrin 0.05 – 0.1% spray</p> <p>Trade name: Tempo</p> <p>Chemical class: Pyrethroid</p>	<ul style="list-style-type: none"> • Mix 9.5 – 19 g 20% WP in 3.75 L water to make a suspension. Apply to 100 m² of surface using a low pressure sprayer. • Apply to all fly resting surfaces. 	<ul style="list-style-type: none"> • Do not apply when animals are present. • Do not allow cattle to re-enter facilities for two hours following application. • Do not allow poultry to re-enter facilities for 24 hours following application. • Apply only in well-ventilated areas. • Do not apply as a space spray. • Cover water bowls in dairies with tight-fitting elastic-banded plastic covers. • Cover feed troughs in dairies with 6 mil plastic sufficient to allow 15 cm overhang on the sides of the trough. • Do not apply directly to water bowls and feed troughs. • Allow sprays to dry before restocking areas.
<p>Chemical name: Diazinon 0.5 – 1% spray</p> <p>Trade name: Diazinon</p> <p>Chemical class: Organophosphate</p>	<ul style="list-style-type: none"> • Mix 100-200 g 50% WP, or 100-200 ml 50% EC/10 L water. • Spray ceilings and walls to the point of runoff, 5 to 10 L/100 m². • Repeat as necessary. • Treat windows and other resting areas. 	<ul style="list-style-type: none"> • Remove animals before spraying and do not allow animals to re-enter for at least four hours after spraying. • Do not use in poultry houses. • Do not use in rooms where milk is processed, handled or stored.
<p>Chemical name: Dichlorvos 0.5% spray</p> <p>Trade name: Various</p> <p>Chemical class: Organophosphate</p>	<ul style="list-style-type: none"> • Mix 300 ml 20% EC/10 L water and apply as a coarse wet spray to areas where insects gather. Use about 5 L/100 m². • Repeat weekly if necessary. 	<ul style="list-style-type: none"> • Remove animals and close doors and windows before spraying. • Ventilate thoroughly before returning animals to barn. • Do not use in rooms where milk is processed, handled or stored. • Do not contaminate feed, water or litter.
<p>Chemical name: Dichlorvos 0.75 – 0.9% ready-to-use spray solution</p> <p>Trade name: Various</p> <p>Chemical class: Organophosphate</p>	<ul style="list-style-type: none"> • Apply 200 ml/100 m² as a mist directed towards ceiling. • Repeat as necessary. 	<ul style="list-style-type: none"> • Remove all animals and close windows and doors before spraying. • Ventilate thoroughly before returning animals to the building. • Do not use in rooms where milk is processed, handled, or stored. • Do not contaminate feed, water, or litter. • Do not spray over milk or milking equipment.

(continued on next page)

Figure 4.9 (continued)

Fly Control Options

Surface and Space Applications - House and Stable Fly	Method	Cautions
<p>Chemical name: Dimethoate 1% spray</p> <p>Trade name: Cygon</p> <p>Chemical class: Organophosphate</p>	<ul style="list-style-type: none"> • Mix 500 ml 24% EC or 250 ml 44% EC/10 L water. Use 5 to 10 L/100 m² of surface, or to point of runoff. • Repeat as necessary. 	<ul style="list-style-type: none"> • Remove livestock and poultry before spraying. • Do not use in rooms where milk is processed, handled or stored. • Do not contaminate feed troughs, drinking fountains or litter. • Do not use in dwellings.
<p>Chemical name: Fenthion 1.5% spray</p> <p>Trade name: Baytex</p> <p>Chemical class: Organophosphate</p>	<ul style="list-style-type: none"> • Mix 300 ml 48% SC/10 L water. Apply 5 L/100 m² to outdoor surfaces of buildings, window frames and other surfaces where flies gather. • Repeat as necessary. 	<ul style="list-style-type: none"> • Do not apply to animals. • Do not use in dairy barns, poultry houses or rooms where milk is processed, handled or stored.
<p>Chemical name: Malathion 1 - 2% spray</p> <p>Trade name: Malathion, Cythion</p> <p>Chemical class: Organophosphate</p>	<ul style="list-style-type: none"> • Mix 200 - 400 ml 50% EC or 800 g 25% WP/10 L water. Apply 5 to 10 L/100 m² of wall and ceiling surface (also manure piles). • Repeat after two to four weeks as required. 	<ul style="list-style-type: none"> • Wait 14 days before applying to freshly whitewashed surfaces. • Remove lactating animals from buildings before treating. • Remove animals under one month of age before treating. • Do not use in dwellings. • Do not use in rooms where milk is processed, handled or stored. • Do not contaminate feeds, foods or water.
<p>Chemical name: Naled 0.25% spray</p> <p>Trade name: Dibrom</p> <p>Chemical class: Organophosphate</p>	<ul style="list-style-type: none"> • Mix 30 ml 86% EC/10 L water. Apply to point of runoff. • Repeat as necessary. 	<ul style="list-style-type: none"> • Do not spray livestock or poultry. • Do not use in rooms where milk is processed, handled, or stored. • Do not use in dwellings. • Do not use in poultry house when birds are present.
<p>Chemical name: Permethrin 0.1% - 0.2% spray</p> <p>Trade name: Ambush, Ecitban, Sentinel</p> <p>Chemical class: Pyrethroid</p>	<ul style="list-style-type: none"> • Mix 40 to 80 ml 25% EC, or 100 to 200 ml 10% EC, or 200 to 400 ml 5% EC/10 L water. Apply at rate of 2.5 to 5 L/100 m² of surface or to point of runoff. • Spray areas where flies congregate. 	<ul style="list-style-type: none"> • Do not apply as a space spray. • Do not apply directly to animals or poultry. • Do not contaminate feed, water, feeding or watering troughs. • Thoroughly clean all milk utensils and equipment before resuming operation.
<p>Chemical name: Pyrethrin mixtures (various ready-to-use sprays)</p> <p>Trade name: Various</p> <p>Chemical class: Botanical</p>	<ul style="list-style-type: none"> • Apply as per label instructions. Leave room closed for 10 to 15 minutes before ventilating. 	<ul style="list-style-type: none"> • Do not contaminate feed or water troughs. • Do not spray over milk or milking equipment.

(continued on next page)



Figure 4.9 (continued)

Fly Control Options

Surface and Space Applications – House and Stable Fly	Method	Cautions
<p>Chemical name: Tetrachlorvinphos 1 – 2% spray</p> <p>Trade name: Debantic</p> <p>Chemical class: Organophosphate</p>	<ul style="list-style-type: none"> • Mix 1 to 2 kg 50% WP/50 L water. Apply about 5 L/50 to 100 m² of surface area where flies congregate. • Repeat as necessary. 	<ul style="list-style-type: none"> • Do not use in milk processing rooms. • Do not apply in combination with whitewash. • Do not treat freshly whitewashed surfaces. • Do not contaminate feed, water or litter.
<p>Chemical name: Trichlorfon 1.25% spray</p> <p>Trade name: Dipterex</p> <p>Chemical class: Organophosphate</p>	<ul style="list-style-type: none"> • Mix 150 g 80% SP/10 L water. Spray 10 L/100 m² or to point of runoff. • Treat floors, walls, ceilings, etc., where flies gather. • Repeat at intervals of 7 to 14 days, or as necessary. 	<ul style="list-style-type: none"> • Remove animals before spraying. • For longer residual control add 1 kg sugar or 1.2 L corn syrup/ 10 L of mixture. • Do not treat portions of buildings where poultry feed or that animals lick. • Do not use in dwellings or milk processing rooms. • Do not contaminate drinking water, milk or milk-handling equipment

Animal Applications

<p>Chemical name: Crotoxyphos + dichlorvos ready-to-use spray</p> <p>Trade name: •••</p> <p>Chemical class: Organophosphate</p>	<ul style="list-style-type: none"> • Apply as a coarse spray to dampen hair on flanks, legs, brisket, head and neck. • Do not apply more than 60 ml/ animal/ day. 	<ul style="list-style-type: none"> • May be applied up to the day before slaughter.
<p>Chemical name: Dichlorvos 0.2% ready-to-use liquid</p> <p>Trade name: Various</p> <p>Chemical class: Organophosphate</p>	<ul style="list-style-type: none"> • Apply product as a fine mist. • Apply at a rate of 30 to 60 ml/ adult cow. • Use only enough to dampen the hair but not enough to wet the skin. • Repeat at daily intervals or as necessary, to give continued protection. 	<ul style="list-style-type: none"> • Do not use more than once per day. • Take care not to spray in animals' eyes or mouths. • Products may contain pyrethrins and/or piperonyl butoxide. • Do not contaminate feed, water or foodstuffs. • Any treated surface that may contact food or feed products should be thoroughly washed with potable water after spraying and before re-use.
<p>Chemical name: Pyrethrin ready-to-use sprays</p> <p>Trade name: Various</p> <p>Chemical class: Botanical</p>	<ul style="list-style-type: none"> • Apply as per label instructions once or twice daily. 	<ul style="list-style-type: none"> • Do not contaminate feed or water trough. • Do not spray over milk or milking equipment.

4.8 Changing Manure Content

Manure's physical and chemical characteristics can vary as a result of modifications to animal nutrition, genetics, pharmaceutical use and composting. Use of commonly accepted feedlot management practices may negatively affect manure composition. Weigh the benefits of increased animal performance, health and profitability against the potential risks associated with the use of these management practices. Many of the impacts of feedlot management practices on manure composition and their ramifications are not fully understood. Therefore, the information contained in the following sections will reflect only what is known to date.

Nutrition

Physical, biological and chemical characteristics of manure can be modified by changing the composition of the animal rations. It has been reported that reducing the nitrogen, phosphorus and salt concentration of manure would be helpful in reducing the potential for water pollution.

Rations should be closely balanced to animal requirements, utilizing highly digestible feeds to avoid excesses in manure. In some cases, growth-promoting compounds increase the ability of animals to utilize available dietary protein more efficiently, thereby reducing levels of nitrogen excreted in the manure.

Chelated minerals may also reduce the amount of excreted minerals by not reacting with rumen contents and being more available to the animal for utilization. This would reduce the overall required amount of mineral supplements. Phytase supplementation has been reported to improve phosphorus utilization of pig and poultry rations since these animals, unlike cattle, lack the enzyme that completely breaks down phytate phosphorus.

Therefore, the easiest way to reduce phosphorus excretion in cattle is to regulate phosphorus intake. Some feedlots utilize by-products in their rations. Many of these by-products (e.g. wheat middlings) are relatively high in phosphorus. Nutrition has a significant impact on the characteristics of the resulting manure. Where possible, it is important that feedlot producers work closely with nutritionists to explore feasible and economical ways to modify feeding programs to minimize manure nutrient content.

Genetics

Manure nutrient content can be influenced by selecting superior cattle that finish early and require less feed per kilogram of gain. These animals will be more efficient converters of nutrients and will be in the feedlot fewer days, thereby reducing the overall amount of nutrients and manure produced per kilogram of beef raised.

Composting (refer to Section 4.5)

Composting of manure converts carbon and nitrogen into more stable organic forms, allowing the compost to maintain a higher nutrient content and a lower potential for adverse runoff during storage and after being field applied. Composting reduces moisture content making trucking to more distant locations feasible. Temperatures reached during the composting process also kills most micro-organisms and weed seeds. It has also been reported that composting can enhance the breakdown of pesticide residues found in manure and can reduce offensive odours. Composting of feedlot manure can have a beneficial effect on nutrient and physical attributes (Figure 4.10).

There is increased interest in composting as a means of handling the large amounts of manure generated by feedlots. However few studies have been conducted on the changes in physical properties of manure as it becomes compost and the impact of these changes on haulage requirements. Additionally, there is a perceived constraint to winter composting in Alberta, due to extremely low air temperatures. A recent study examined active (mechanically turned) and passive (passive aeration system) windrow composting during winter and summer in southern Alberta, and found that:

- Dry matter mass reductions were in the range of 21 to 30 percent.
- Bulk density increased three to four fold with both types of composting.
- Volume loss during the thermophilic phase was of the order: summer-active (72 percent) > summer-passive (55 percent) > winter-active (51 percent) > winter-passive (34 percent) with further small losses during the curing phase.
- Water mass loss was as high as 83 percent for active composting during summer.



Figure 4.10

Nutrient and Soil Amendment Quality of Fresh, Feedlot and Composted Cattle Manure

(Based on values cited in literature. DeLuca et al, 1997)

	Fresh Feces		Feedlot Manure		Composted Manure		Reference
	Range	Avg.	Range	Avg.	Range	Avg.	
N % wet weight	0.4–0.9	0.6	0.3–2.4	1.4	0.6–1.5	1.1	1,2,3,4,5
P % wet weight	0.1–0.2	0.2	0.1–0.8	0.4	0.3–0.8	0.5	1,2,4
K % wet weight	0.2–0.5	0.3	0.2–1.4	0.8	2.0–1.5	1.7	1,2,4
Moisture %	80–90	85	30–70	50	10–50	30	2,4,6
Phenolics, ppm		827		1245		41	7
Pathogens, weed seeds, insect larvae, odours	++	+		+		-	4,5,8,9

* Source: 1. Brinton, 1985; 2. Chaney et al., 1992; 3. Hebert et al., 1991; 4. Overcash et al., 1983; 5. Taiganides, 1977; 6. Rynk et al., 1992; 7. Paul et al., 1994; 8. Pfirter et al., 1981; 9. Mawdsley et al., 1995.
 ++ = present, - = absent or greatly reduced.

- Active composting generally led to larger changes in physical properties of manure than passive composting.
- Winter composting was feasible despite ambient air temperatures <-30 C.

The results demonstrate the ability of composting to substantially reduce the mass, volume and water content of manure that needs to be transported for land application.

Veterinary drugs

Several feed additives are registered for the feedlot industry. They have a variety of uses including improving feed efficiency, bloat reduction, parasite control and treatment of liver abscesses. Some of these products are antibiotics, such as monensin sodium (Rumensin), salinomycin sodium (Posistac), and tylosin (Tylan).

A portion of the unmetabolized antibiotic may be excreted in the urine or feces. It is advisable to use antibiotics prudently, whether administered in feed or water, given topically or injected, to avoid manure runoff into water sources. Loss of antibiotics by volatilization and degradation from manure is dependent on the chemical properties of the specific antibiotic. Contact a veterinarian for prudent use guidelines for antimicrobials.

Hormones, typically administered to cattle in the form of an ear implant to increase weight gain, may include estradiol, testosterone, zeranol, trenbolone, or progesterone. Research has reported certain growth hormones can be excreted in the feces and urine. It is important that feedlot operators use registered implants according to the label instructions and prevent manure from coming into contact with water sources.

Endectocides are used to control internal and external parasites of cattle. A wide variety

of products are registered. These products are excreted in the feces where they can reduce some insect activity in dung pats from treated animals. This could be a positive attribute if affected insects are species like the horn fly and face fly, but may be detrimental when it affects beneficial insects that are involved in dung pat breakdown.

In feedlot situations, the impact of slowed dung pat breakdown is minimal since low residue levels found in feedlot manure are further diluted when the manure is incorporated into cropland as fertilizer. Also, residues have been reported to bind tightly to soil particles, which reduces the risk of runoff and groundwater contamination. Recent research shows that the effect of endectocide residues on dung insects varies with the product used.

Manure may contain residues of pharmaceuticals. Reduce risks of environmental contamination by:

- Prudently using pharmaceuticals.
- Controlling runoff and leaching.
- Stockpiling and spreading manure with adequate setbacks from rivers, streams, lakes and ponds.

Research

Nutrition, genetics, composting and pharmaceutical products affect the composition of feedlot manure. This area of research is quickly expanding, so all of the answers are not known. Feedlot operators should seek out new information as it becomes available, evaluate and discuss the information with a nutritionist, veterinarian and feedlot consultant, and implement those management practices that make sense from a production, economic, and environmental standpoint.

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5.0 LAND APPLICATION OF MANURE

Manure or compost application to land can be a sustainable agricultural practice, provided proper nutrient management practices are followed. Manure is an organic fertilizer and is a source of plant nutrients. Manure can also improve soil tilth, structure, aeration, and water-holding capacity. This is particularly true for light-textured soils low in organic matter, or degraded soils.

Manure serves as a viable substitute for commercial inorganic fertilizer because of its on-farm availability, nutrient composition and ability to enhance the organic matter content of soil. However, if manure application is not properly managed, excess nutrients may be applied to agricultural land. In addition to nutrients, micro-organisms (including pathogens), weed seeds, and salts are also present in manure.

Risks that can be associated with manure and compost application include:

- Excess phosphorus (P) and nitrogen (N) application on land from manure and mineral fertilizer may result in phosphorus runoff to surface water bodies and nitrate leaching to groundwater.
- Excess phosphorus in water bodies may cause excessive growth of aquatic plants. The decomposition of these plants can reduce oxygen to critical levels, which adversely affects fish survival.

- Organic matter in a water source may cause physical and biological damage, including oxygen depletion.
- Excess nitrates may reduce ground or surface water quality, eventually making it toxic to aquatic life, humans and livestock.
- Disease-causing organisms may contaminate water, making it unsuitable for human and livestock consumption.
- Ammonia toxicity can poison fish and other aquatic organisms.
- Nitrogen gases, including ammonia and nitrous oxide (greenhouse gas), may reduce air quality.
- High salinity in manure may decrease soil quality.

In this section, Nutrient Management Planning (NMP) will be addressed by outlining some possible Beneficial Management Practices (BMPs) related to land application of manure or compost. The overall objective of a NMP is to effectively use manure, compost and/or mineral fertilizers as nutrient resources for optimum crop production in a manner that will reduce the impact of agriculture on the environment.

5.1 Nutrient Value of Manure

Manure should be managed as a resource to maximize its benefits and minimize its risks. Nutrients can be effectively recycled when manure is used as a fertilizer, which can reduce the need for commercial fertilizers.

To use manure as a resource, it is important to understand its composition. Manure is a mixture of water, organic matter, minerals, nutrients and other chemicals. The proportion

of each component and the nutrient profile of the manure depends on animal species and age, manure storage and handling, bedding material and animal feed. The nutrients available in manure are nitrogen, phosphorus, potassium, calcium, magnesium, sodium, sulphur, and micronutrients, such as boron, chlorine, copper, iron, molybdenum, zinc, selenium, chromium, iodine and cobalt.

5.1.1 Nitrogen and phosphorus

Manure provides the same essential nutrients for crop production as commercial fertilizers, but the challenge with manure is that the forms and ratio of the nutrients are not easy to change. Nitrogen in manure is found as ammonium or as organic compounds. Environmental risk is associated with losses to groundwater through leaching or losses to air through denitrification and volatilization. Phosphorus is present in organic and inorganic forms, and the risk to the environment is phosphorus loss through surface runoff from spring snowmelt, seasonal rainfall and soil erosion.

Facts about nitrogen and phosphorus:

- Only ammonium and nitrate (mineral or inorganic nitrogen) can be used by plants.
- Organic nitrogen must be transformed to ammonium (mineralization) and nitrate (nitrification) forms before plants can use it.
- Phosphorus is generally found in three forms: particulate phosphorus (P attached to sediments), dissolved phosphorus (water soluble P) and organic phosphorus.
- Soil test nitrogen and phosphorus are used as indices for plant available nitrogen and phosphorus. These indices can be used to determine if additional nitrogen and phosphorus are required for optimum crop growth. Soil test phosphorus can also be used in the assessment of potential phosphorus runoff losses.

Figure 5.1 Nitrogen and Phosphorus in Manure*

	Form in Manure	Available 1st year	Available 2nd year	Available 3rd year	Risks of contamination
Nitrogen (N)	<ul style="list-style-type: none"> • Ammonium (NH_4^+) • Nitrate (NO_3^-) • Organic N 	$\text{NH}_4^+ + \text{NO}_3^- + 25\%$ of initial organic N content	12% of initial organic N content	6% of initial organic N content	<ul style="list-style-type: none"> • Nitrate in groundwater • Volatilization** of ammonia • Denitrification*** as nitrous oxide
Phosphorus (P)	<ul style="list-style-type: none"> • Inorganic P (H_2PO_4^- & HPO_4^{2-}) • Organic P 	50% of initial total P content	20% of initial total P content	6% of initial total P content	<ul style="list-style-type: none"> • P in surface runoff (particulate and dissolved) • P leaching into groundwater

* The percentages listed in the Figure are only estimates. The availability of nutrients from organic sources, such as manure, depends on biological processes in the soil, and these processes are affected by many factors, such as temperature, moisture, and soil type.

** Volatilization is the gaseous loss of a substance (e.g. ammonia) into the atmosphere.

*** Denitrification is the transformation of nitrate to gaseous forms under high moisture or saturated soil conditions, which can be lost to the atmosphere.

To reduce nitrate leaching:

- Apply manure based on the nitrogen rate from soil test recommendations.
- When a high amount of nitrogen is required, split the application into two-thirds manure and one-third mineral fertilizer of the total amount required. Also, apply mineral fertilizer later in the season.
- Reduce the amount of time between application of manure and the highest demand for nitrogen uptake by the crop (e.g. apply in spring while plants are actively growing).
- Do not apply if heavy rain is predicted.

- Do not apply near streams or other water bodies. A person must not apply manure within 30 metres of an open body of water if the person is applying the manure to the surface and incorporating it within 48 hours, or within 30 metres of a water well.

To reduce ammonia loss into air:

- Apply manure on humid and/or cold non-windy days.
- Incorporate manure as soon as possible.

To reduce denitrification:

- Avoid manure application in low, wet areas.
- Apply manure prior to seeding, so nutrients can be used while plants are actively growing.

To reduce phosphorus in surface runoff and soil erosion:

- Test soil phosphorus at least once every three years and avoid over-applying fertilizers or manure. Over-application of fertilizers or manure will raise phosphorus levels above the soil test recommended agronomic levels (contact a crop adviser or soil laboratory for recommended P levels for each crop).
- Apply manure according to soil test recommendations, crop yield goals and manure analyses. If manure is not analyzed for nutrient content, book values can be used (*Agricultural Operation Practices Act* [AOPA]). This will reduce excess nutrients in the soil and minimize buildup.
- Adopt phosphorus-based nutrient management plans for areas and soils that are particularly vulnerable to phosphorus runoff or leaching, (e.g., flood plains, steeply sloped land, land with high water tables or shallow aquifers).
- Inject or incorporate fertilizers and manure to avoid losses by runoff. The deeper manure is incorporated, the lower the soil test P value will be and the lower the potential for P runoff.
- Incorporate manure within 48 hours.
- Do not apply manure within 30 metres of an open body of water or within 30 metres of a water well.
- Apply manure when it can be incorporated (avoid spreading manure on frozen soil).
- If manure is applied on forage or direct-seeded crops or the land is frozen or snow-covered, application must be in accordance with the nutrient limits, other manure application requirements (e.g. proximity to water), and must not adversely impact groundwater, surface water, or create an odour nuisance. Surface application of manure on frozen or snow-covered land or on forage and direct-seeded crops without incorporation is only acceptable if the following minimum setback distances are met (Figure 5.2). Surface water that comes in contact with surface-applied manure must not enter an open body of water or leave the owner's property.
- Currently there are no soil phosphorus limits in Alberta, but research is underway to identify environmental limits for soil phosphorus.

Figure 5.2 Minimum Setback Distances for Application of Manure on Forage or Direct-Seeded Crops or on Frozen or Snow-Covered Land

Mean Slope	Required Setback Distance from Open Body of Water
Less than 4%	30 m
4% but less than 6%	60 m
6% but less than 12%	90 m
12% or greater	No application allowed

To reduce nutrient losses by wind and water erosion:

- Leave some of last year's crop residue on the surface and reduce tillage. This increases water infiltration and reduces nutrient losses in wind-blown sediments and runoff.
- Build a runoff control basin or an embankment across a depression of concentrated water in a field. The embankment will act as a terrace, trapping sediments, slowing water movement and reducing gully erosion. By slowing water movement, the re-deposition of P in the field will increase.
- Construct a terrace by breaking longer slopes into shorter ones.
- Establish grassed waterways in erosion-prone areas to slow water movement from the field.



5.1.2 Salt

Manure can contain significant amounts of salt that may affect soil quality.

Facts about salt:

- Management of soil salinity is crucial to the sustainability of land production.
- Salt can degrade soil quality and its ability to produce crops. High levels of sodium disperse aggregates in soil, which reduces soil infiltration.
- Salinity levels may reduce crop production, or limit crop selection (contact a crop advisor for information on crop salinity tolerance).

To reduce soil salinity:

- Monitor salt levels in feed rations (contact a livestock nutritionist for recommended levels).

- Monitor the electrical conductivity (EC) level in soil. Electrical conductivity is a measurement of soil salt content, and a change of more than 1 dS/m may indicate a soil quality problem. If the EC is more than 2 dS/m, plant growth and yield may be affected. If the EC is more than 4 dS/m, do not apply manure.
- Monitor the sodium adsorption ratio (SAR) levels in soil. The sodium adsorption ratio is a measurement of sodium in relation to calcium plus magnesium. Sodium adsorption ratio levels above eight in soil can decrease soil permeability and increase the potential for water logging.
- In soils with a high EC and high SAR, do not apply manure.

5.2 Manure and Soil Analysis

Manure analysis provides information on nutrient content in manure. Based on nutrient analysis, the amount of nutrients available for crop growth can be estimated. To estimate crop-available nutrients in manure, many factors have to be considered, such as the chemical makeup of the nutrients in manure, volatilization, mineralization (breakdown of organic matter into available plant nutrients), and immobilization (transformation of crop-available nutrients into organic forms). When calculating manure application rates, include residual crop-available nutrients from manure applied in recent years.

Accurate manure analysis and application are important, because problems can result from either inadequate or excessive nutrients in the soil. Manure analysis recommendations are based on:

- Nutrient content in manure.
- Crop to be grown.
- Soil type.
- Soil test.
- Climate.
- Soil moisture.
- Other management practices, such as dryland versus irrigation.

5.2.1 Manure analysis

As a good practice, it is recommended to analyze manure for three to five consecutive years before using the manure values in order to get representative data. Compare manure test results to the manure nutrient book values. Use the feedlot's manure test results in completing the nutrient management plan, rather than book values, unless there is a large

discrepancy between the manure nutrient values and the book values. If a large discrepancy exists, consult an agronomist on which manure nutrient values to use.

Although the best source of information is from sampling the feedlot's manure, book values of nutrient content are available (e.g., AOPA).

5.2.1.1 Manure sampling

Manure testing helps generate a long-term database for planning and economic evaluation, as well as demonstrating due diligence. It is important that manure samples represent the entire volume of manure, not just the surface layer. Achieving an appropriate manure application rate is closely related to how manure samples are collected.

For manure sampling:

- Collect composite samples that reflect the overall variability of the manure.
- When sampling solid manure containing bedding and other materials, all compounds should be in the same proportion in the sample as they are in the pile.
- Collect about 20 samples, one from each manure source. Mix the samples together and remove a sub-sample (about 1 kilogram), and place in a sealed container. Keep cool and send to the laboratory as soon as possible.
- Sampling before, but as close to land application as possible, helps build an accurate database. For accuracy, collect solid manure samples from the manure truckloads (take three to four samples per load).
- Use the manure analysis information to determine manure application rates.

5.2.1.2 Manure handling and shipping

A good understanding of how manure is handled helps to characterize the spatial variability of manure composition in different manure piles, and assists in the collection of a good representative sample.

For manure handling:

- Avoid any handling that can alter the physical and chemical composition of manure samples (i.e., leakage, nutrient loss to the air, loss in moisture, room/warm temperature).
- Use sealable freezer bags for solid manure. Seal the bag and prevent leakage by putting the bag inside another freezer bag (double bagging).
- Send samples immediately to the lab. Otherwise, freeze the sample until delivery.
- In all situations, the container should be only half-full and labelled with name, date and storage identification. The sooner the sample is sent to the lab, the more reliable the laboratory results will be.
- Contact the laboratory prior to sampling to obtain specific information on sample size, shipping instructions and cost.

Manure laboratory results:

- Manure tests should at least include percentage dry matter, total nitrogen, ammonium nitrogen and total phosphorus. If there is the possibility of other soil differences, other nutrients can be measured, such as potassium, sulphur and micronutrients. Analyzing electrical conductivity and sodium adsorption ratio is only necessary to determine if changes in feed rations have affected manure quality. It is more important to monitor soil salinity.
- Manure test results should be in the same units used for calibrating the manure application equipment (pounds or kilograms). Take special care when converting units.
- Manure nutrient results should be on a wet (or “as is”) basis, since manure is spread wet.

5.2.2 Soil analysis

Soil analysis is used as an index for nutrient availability in soil. Decisions about nutrient management cannot be made without knowing the nutrients available in the soil and their levels. The higher the soil test, the lower the application rate of fertilizer. An accurate soil test (proper soil sampling and interpretation of soil test), can be an excellent nutrient

management tool. However, misuse of a soil test leads to increased costs, yield losses, and/or environmental contamination. Soil tests should be used to indicate nutrient or salt excesses. If an excess is found, manure application rates should be based on the excess nutrient; then inorganic fertilizer can be used to supplement other nutrient levels.

For soil sampling:

- Collect a representative sample, based on in-field variations in topography (slope), soil type, cropping management and cropping history.
- Collect soil samples from depth intervals of 0 to 15 centimetres, 15 to 30 centimetres and 30 to 60 centimetres at 20 to 30 sites per field or field management area. Place samples from each depth in a separate container. Sample to greater depths (60 to 90, 90 to 120, and 120 to 150 centimetres) every 3 to 5 years to check for nitrate leaching in fields that receive regular manure application or fields with a history of heavy manure application.
- Mix samples taken from same depth intervals and remove about a 0.5 kilogram sample from each depth.
- A soil-sampling probe is best for taking samples. Augers can also be used, but it can be difficult to accurately separate the sample into depth intervals. Tools may be borrowed or purchased from fertilizer dealers or some soil testing laboratories.
- Ideally, samples should be taken prior to seeding, but if time is a constraint, fall sampling is the best alternative. Because changes in soil nutrients are slower below a soil temperature of 7 C, collect samples at or below this temperature, but prior to freeze-up.

- Analyze soil for at least plant-available nitrogen and phosphorus. Analyze for other nutrients (sulphur, potassium, micronutrients), if it is suspected that the soil may be deficient. It is also important to monitor soil salinity (EC), and possibly SAR on a regular basis.

Soil test interpretations:

- If nutrient recommendations are included in the laboratory report, there is no need for soil test interpretations.
- If recommendations are not included with soil test results, consult with a crop advisor or private consultant to provide nutrient recommendations.
- Not all manure will have the right composition to meet crop requirements. Nutrients are not present in organic materials in the same proportion needed by crops.
- Adjust application rates to meet the requirement for nutrients that will result in the lowest application rate. Inorganic fertilizers can be used to supplement other nutrients to the recommended levels.
- Avoid yearly applications to the same land, unless manure and soil tests indicate there is no risk of excess nutrient levels.

5.3 Crop Nutrient Requirements

Nutrient requirements vary from one crop to another. Therefore, for the same conditions, application rates will be different depending on the crop. Targeted yield for a given crop is an important factor in determining the amount of nutrients to add. Crop yield targets are used to determine nutrient requirements and the manure rate. To estimate targeted yield, average the yields of the previous four harvests for a given field and add five to ten percent as an expected improvement factor.

The overall objective for considering manure and soil analyses, as well as cropping system components, is to determine an accurate manure application rate. An illustrated example is presented as a case study at the end of this section, to show how all the components are integrated.

To determine crop nutrient requirements:

- Apply the manure with the highest nutrient content to crops with the highest nutrient requirements. (Figure 5.3)
- Generally legumes do not require additional N; therefore do not apply manure with high N content.
- Apply manure with the lowest nutrient content to fields closest to the manure storage site and manure with the highest nutrient content to the farthest fields. This reduces the cost of hauling, as a lower amount of manure is needed when nutrient concentration is higher.

Figure 5.3 Nutrient Uptake and Removal by Various Crops

Crop		Yield tonne* or kg/ha	N	P ₂ O ₅	K ₂ O
			kg/ha		
Spring Wheat	Removal	2690	67	27	20
	Uptake	2690	95	36	82
Winter Wheat	Removal	3360	55	29	19
	Uptake	3360	76	35	80
Barley	Removal	4300	87	38	29
	Uptake	4300	124	50	120
Oat	Removal	3810	69	29	21
	Uptake	3810	120	46	164
Rye	Removal	3450	66	28	22
	Uptake	3450	103	52	147
Corn	Removal	6280	109	49	31
	Uptake	6280	171	71	145
Canola	Removal	1960	76	41	20
	Uptake	1960	126	58	91
Flax	Removal	1510	57	18	17
	Uptake	1510	80	22	49
Sunflower	Removal	1680	61	18	13
	Uptake	1680	84	29	41
Potato	Removal	45*	143	41	242
	Uptake	45*	255	75	334
Pea	Removal	3360	131	39	40
	Uptake	3360	171	47	154
Lentil	Removal	1290	68	21	37
	Uptake	1290	103	28	86
Alfalfa		11*	103	28	86
Clover		9*	255	75	334
Grass		7*	242	63	226
Barley Silage		10*	115	34	146
Corn Silage		11*	174	59	138

Conversion of yields to metric units assumed the following bushel weights (in pounds per bushel): wheat = 60; barley = 48; oat = 34; rye = 56; corn = 56; canola = 50; flax = 56; sunflower = 30, pea = 60; and lentil = 38.

P₂O₅ x 0.4364 = P

K₂O x 0.8301 = K

kg/ha x 0.8924 = lbs./ac.

tonne/ha x 0.4461 = ton/ac.

Source: Fertilizer Institute of Canada (Modified)

5.4 Method of Manure Application

Different methods of manure application have been developed to:

- Optimize nutrient availability.
- Minimize nutrient losses.
- Minimize odour.
- Optimize uniform manure spread.

Choosing a method of manure application depends on the physical characteristics of manure (liquid or solid), type of operation, handling and storage, type of spreader and cost.

The choice of application options can be determined by answering four key questions:

- Does this option optimize nutrient availability?
- Does this option minimize nutrient losses?

- Does this option minimize odour?
- Does this option allow for spreading manure uniformly?

For solid manure, surface application with incorporation is the best management practice. Incorporation can be achieved by knifing, plowing or discing. The sooner solid manure is incorporated, the lower the nitrogen loss to the air. Incorporation of solid manure considerably reduces odour nuisance. Incorporation also reduces the risk of nutrient losses by surface runoff. Research is currently underway to determine the method of manure incorporation that best protects surface water quality.

5.5 Time of Application

The best time to apply manure is before the early stages of crop growth. The longer the time between manure application and the stage at which the crop can use the nutrients, the higher the risk of nutrient losses from the

soil. Within a given season, nitrogen loss by ammonia to the air from surface applications is higher on dry, warm, windy days than on days that are humid and/or cold.

Figure 5.4 Timing of Manure Application

Season	Beneficial Management Practice	Watch For
Winter	<ul style="list-style-type: none"> • Manure should go into storage. • Avoid application on frozen or snow-covered ground. • Apply on level, non-sensitive areas and only in emergencies. (see Figure 5.2) • Avoid spreading on land with a history of floods or heavy runoff. • In case of emergency, apply on grass or winter cover crops or on areas with high crop residue where there is less possibility of runoff or flooding. 	<ul style="list-style-type: none"> • Runoff that can pollute surface water. • Manure that soaks in too slowly on wet fields and runs off with excess water. • Wet soils that are prone to compaction.
Spring	<ul style="list-style-type: none"> • Apply to land designated for annual crops before seeding. • Apply to row crops as a side dressing after plants emerge. • Work manure into soil within 48 hours of application. • Apply to well-drained soils. 	<ul style="list-style-type: none"> • Wet soils that are prone to compaction. • Denitrification in cold, wet soils. • Excessive application, which can create a pollution hazard. • Planting too soon after heavy manure application, which can create ammonia toxicity and reduce germination and seedling growth.
Summer	<ul style="list-style-type: none"> • Apply to grasslands. • Apply lightly to hay fields after cuttings. • Apply to pasture early to avoid trampling re-growth. • Compost manure to reduce odour and break up clumps. • Do not apply to mature crops; they don't need nutrients. • See Figure 5.2 for application on forages and direct-seeded crops. 	<ul style="list-style-type: none"> • Loss of nitrogen if there is no rainfall within 72 hours. Rain helps manure soak in.
Fall	<ul style="list-style-type: none"> • Apply to annual cropland that will be planted with winter cover crops (this may not always be feasible – feedlots apply manure in the spring and fall following pen clean-out). 	<ul style="list-style-type: none"> • Denitrification in cold, wet soils. • Application: apply only on well-drained soils. • Manure that soaks in too slowly on wet fields; and runs off with excess water. • Wet soils that are prone to compaction.

Spring application is the most desirable for Alberta conditions as high nutrient availability time matches crop uptake. The downsides of spring application are the limited opportunities for application due to inclement weather and risk of soil compaction.

Source: *Best Management Practices, Livestock and Poultry Waste Management: Agriculture and Agri-Food Canada and Ontario Ministry of Agriculture and Food, 1994.*

5.6 Calibration of Spreading Equipment

Spreading is an important operation in manure management. Possibilities for over or under-application are significant. Therefore, it is crucial to correctly calibrate manure-spreading equipment. It is ineffective to do proper soil and manure analyses and determine application rates based on targeted crop yield, if spreading is not accurate.

Equipment calibration should address the rate and uniformity of application. In fact, one of the main concerns in manure application is how uniformly nutrients are distributed. Uneven distribution of nutrients in the field creates areas where crop yield may be depressed by either excess or insufficient nutrients. The other concern is how to deliver the intended manure application rate.

The two main reasons for calibrating manure spreaders are:

- To provide information on the actual rate applied, (therefore, the exact amount of nutrient applied).
- To allow for an accurate rate of application, (in this case, speed and delivery rates are the parameters to be determined).

Calibrate the spreader with manufacturer guidelines to ensure proper rate of application before each use. Check all parts of spreader to

ensure proper working order. Refer to Section 5.10 for more information on equipment calibration.

There are several methods that can be used to calibrate spreading equipment; all are based on a weight per area basis. One method is to lay out several tarps (3 by 3 metres in size) and drive over them with the spreader. Weigh each tarp with manure and subtract the weight of the tarps. By knowing the area of the tarps, the application rate can be calculated. This method is quite variable and many tarp samples are required to obtain an accurate value. To check on uniformity of application, lay five small tarps side-by-side in a row. Then drive the spreader over the tarps perpendicular to the row. Weigh the manure on each tarp. In addition to checking uniformity, application rate can also be calculated.

Another method is to simply weigh several spreader loads of manure and determine the area in the field that is covered after spreading. Determine the tare weight of the spreader and fill each load equally. Once the calibration rate is determined, rate adjustments can be made by adjusting the equipment and/or varying the ground speed.

5.7 Record Keeping

Recording and keeping all documents related to nutrient management is important. Documents address how nutrient management is implemented on the farm and where and when changes are needed. As well, keeping records will help to generate accurate on-farm data that can be used to generate site-specific information.

Records that must be kept according to AOPA:

- Volume or weight of manure production.
- When receiving manure from another person, the name and address of the person, the date of the transfer and the weight transferred, must be recorded.
- If applying manure at 300 tonnes or more per year, keep the following records:
 - legal land description of land to which manure is applied.

- area of land to which manure is applied.
- date manure applied.
- weight of manure applied.
- application rates of manure nutrients and fertilizer by field and year.
- dates of application and incorporation, and methods used for each field.
- soil test results by field.

Other records that would be helpful to keep include:

- Farm manure production by type of animal and stage of production.
- Manure analyses by type or by storage unit.
- When and how manure is incorporated.
- Crops planted and yields by field and by year.

Records should be kept for five years.

5.8 Other Beneficial Management Practices

5.8.1 Determine soil limitations

Not all soils are the same. In fact, the same manure application rate has different effects on different soils. When making decisions on manure application, consider these factors related to soil type:

- Leaching potential.
- Runoff potential.
- Erodibility.

5.8.2 Determine proximity limitations

Manure and nutrients must be managed with significant precaution near open bodies of water, wells, rivers, creeks, and drinking water supplies to reduce the risk of contamination.

Take into account connectivity to water bodies, runoff and erosion potentials when applying manure.

5.8.3 Determine cropping system limitations

Extra precautions are necessary when manure is used on reduced or no-till fields, pasture or cover crops. In these systems, incorporation of manure is partial or not

possible. Therefore, risk of runoff losses are relatively high depending on the landscape (see Figure 5.2).

5.9 References

- Davis, J., 2000. *Personal Communication*. Colorado State University, Colorado, United States.
- Gillund, G., L.P. Penney and B. Kennedy, 1999. *Practical Manure Management*. pp. 47-51 in: *Proceedings of Manure Management, 1999*. June 22-25, 1999. Saskatoon, Saskatchewan.
- Ontario Ministry of Agriculture, Food and Rural Affairs, 1998. *Soil Fertility Handbook*. K. Reid, Editor. Queen's Printer for Ontario, Toronto, Ontario.

5.10 Appendix: Manure Spreader Calibration

Two key elements are necessary for proper manure application. The first is to determine how much manure is needed, and the second is to correctly calibrate manure spreader equipment.

- Calibrating manure application equipment is essential.
- Knowing the application rate of the spreader is the only way to correctly apply manure to meet crop needs and to reduce the risk of surface and groundwater contamination.
- Land application of manure should be given the same attention as spreading of commercial fertilizer, including calibration of the application equipment.
- Ensure that manure spreaders have an even load and a uniform spreading pattern.

Weigh a load of manure and measure the area it will cover. Calculate the application rate by dividing the weight of manure by the area covered. This method tends to be the most practical.

A relatively good estimate of the application rate can be obtained by counting the number of manure loads needed per field, multiplying this by the weight of each load and dividing by the area of the field.

$$\text{Rate of application} = \text{weight/area}$$

Example:

Conversion Factors:

1 kilometre (kg) = 1,000 metre (m)

1 hectare (ha) = 10,000 m²

1 tonne = 1,000 kilogram (kg)

STEP 1: Amount of manure applied = Truck weight loaded - Truck weight empty = (8 tonnes as an example).

STEP 2: Surface spread = [Width covered by spreader] x [Length].

Width covered by spreader is given by manufacturer or can be measured.

For an example, use 9.5 m.

Length is the distance covered by the spreader from start (loaded) to finish (empty).

Assume 0.4 km = 0.4 x 1,000 = 400 m.

Then,

Surface spread = 9.5 m x 400 m = 3,800 m² = (3,800/10,000) = 0.38 ha.

STEP 3: Rate of application = (8 tonne/0.38 ha) = 21.1 tonne/ha.

The spreader speed should be consistent in order to maintain the same calculated rate of application.

Another important consideration is making sure the manure load is level. If there is more manure on one side of the truck, the spreading pattern will not be even. Spreading manure with beater spreaders can be highly variable. The application rate at the beginning and end of each load of manure may be lower than average, but this can be compensated for by overlapping the runs and by changing the direction of spreading from application to application. The key is to ensure all loads are filled to a similar volume.

5.11 Case Study

This example plan will illustrate, step-by-step, all the information reported in this chapter, regarding the concept of nutrient management planning. As an example, a sample beef farm with four fields (Fields 1 to 4) will be used. Two lots of different manures (Lot 1 and Lot 2) will be identified.

STEP 1: Determine on-farm manure production.

The implementation of manure nutrient management plans starts with an estimate of on-farm nutrient resources. Determination of manure production can be estimated by storage capacity, or by herd size and the average daily, monthly or yearly production. (See *Agricultural Operation Practices Act [AOPA], Standards and Administration Regulation, Part 2, Schedule 3, Table 6.*)

$$\text{Estimated Manure Production EMP (a)} = [\text{Herd size}] \times [\text{Production per head per year}]$$

Example:

Beef herd size:

- feeders = 8,000
- feeder calves = 400
- cow/calf = 800

Manure produced:

- 1.39 tonne/year for feeders.
- 0.54 tonne/year for feeder calves.
- 2.95 tonne/year for cow/calf.

(Reference: manure production volume: AOPA, Schedule 3, Table 6)

Therefore:

$$\text{Estimated Manure Production} = (8,000 \times 1.39) + (400 \times 0.54) + (800 \times 2.95) = 13,696 \text{ tonnes/year.}$$

STEP 2: Analyze manure.

Example:

Assume two different manure piles that are handled differently. The lab results are:

Lot 1

Total N = 10 kg/tonne.

Ammonium N = 3 kg/tonne.

Total P = 1.1 kg/tonne = $1.1 \times 2.2914 = 2.5$ kg/tonne P_2O_5 .

Total K = 5.0 kg/tonne = $5.0 \times 1.2046 = 6.0$ kg/tonne K_2O .

Lot 2

Total N = 6.0 kg/tonne.

Ammonium N = 2.0 kg/tonne.

Total P = 0.7 kg/tonne = $0.7 \times 2.2914 = 1.6$ kg/tonne P_2O_5 .

Total K = 4.2 kg/tonne = $4.2 \times 1.2046 = 5.0$ kg/tonne K_2O .

N - nitrogen
P - phosphorus
 P_2O_5 - phosphate
K - potassium
 K_2O - potash

STEP 3: Calculate available nutrients in manure.

Calculate available nutrients and ammonia loss in manure for the current application using the following equations:

$$\text{Organic N} = \text{total N} - \text{Ammonium N}$$

$$\text{Available N} = [\text{organic N} \times 0.25] + [\text{Ammonium N}] - [\text{Ammonium N} \times \text{Loss Coefficient}]$$

$$\text{Available P}_2\text{O}_5 = \text{total P}_2\text{O}_5 \times 0.5$$

$$\text{Available K}_2\text{O} = \text{total K}_2\text{O} \times 0.9$$

Note: The 0.5 and 0.9 factors are assumed availability factors for P and K, respectively, during the first year after application.

Figure 5.5 Predicted Losses in Percent of Ammonium N between Spreading and Incorporation of Manure under Various Weather Conditions

Treatment	Average	Cool Wet	Cool Dry	Warm Wet	Warm Dry
Spring/Summer					
Incorporated within 1 day	25	10	15	25	50
Incorporated within 2 days	30	13	19	31	57
Fall					
Early	66	40	50	75	100
Late	25	25	25	25	25
Cover crop if grown after manure application	35	25	25	40	N/A

Losses expressed as percentage of total ammonium N spread.

Adapted from Janzen, 1998 and Danesh et al., 1999.

Example:

Lot 1

Assume manure will be incorporated within 48 hours, thus ammonia loss rate is 30 percent (0.30).

$$\text{Organic N} = 10 - 3 = 7 \text{ kg/tonne.}$$

$$\text{Available N} = (7 \times 0.25) + [3 - (3 \times 0.30)] = 3.9 \text{ kg/tonne.}$$

$$\text{Available P}_2\text{O}_5 = (2.5 \times 0.5) = 1.3 \text{ kg/tonne.}$$

$$\text{Available K}_2\text{O} = (6 \times 0.9) = 5.4 \text{ kg/tonne.}$$

Lot 2

Assume manure will be incorporated within 48 hours, thus ammonia loss rate is 30 percent (0.30).

$$\text{Organic N} = 6 - 2 = 4 \text{ kg/tonne.}$$

$$\text{Available N} = (4 \times 0.25) + [2 - (2 \times 0.30)] = 2.4 \text{ kg/tonne.}$$

$$\text{Available P}_2\text{O}_5 = (1.6 \times 0.5) = 0.8 \text{ kg/tonne.}$$

$$\text{Available K}_2\text{O} = (5 \times 0.9) = 4.5 \text{ kg/tonne.}$$



STEP 4: Determine nutrient recommendations.

Determine nutrient recommendations based on soil tests, crop and expected yield.

When requested, nutrient recommendations are listed in the laboratory report. If not, contact AAFRD specialists or private consultants to help determine nutrient recommendations.

For a given field, a combination of AOPA, soil test, crops and targeted yield data should be used to determine nutrient recommendations.

Example:

Figure 5.6 Nutrient Recommendations for Each Field

Field	Soil Tests			Nutrient Recommendations		
	N kg/ha	P ₂ O ₅ kg/ha	K ₂ O kg/ha	N kg/ha	P ₂ O ₅ kg/ha	K ₂ O kg/ha
1	22	34	505	180	35	0
2	56	34	505	110	35	0
3	45	17	505	190	65	0
4	90	34	168	55	45	65

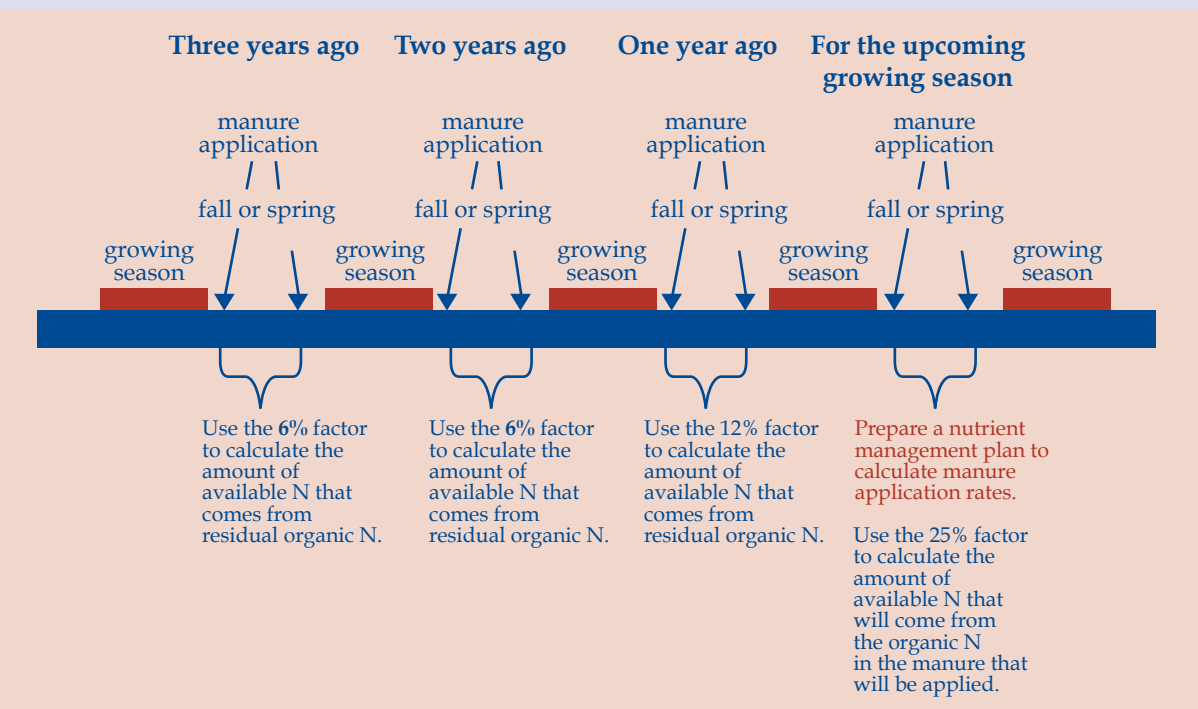
STEP 5: Calculate residual available nitrogen (N).

Calculate the residual available nitrogen carryover from previous manure applications using the following equation:

$$\text{Residual Available Nitrogen} = [0.12 \times \text{amount of manure applied one year ago} \times \text{Organic N content of that manure}] + [0.06 \times \text{amount of manure applied two years ago} \times \text{Organic N content of the manure}].$$

Determine the previous year’s application by using the following diagram.

Figure 5.7 Residual Organic N in Manure



For Residual Available Nitrogen, refer to Figure 5.8.

Residual Available Nitrogen (Column 6, Figure 5.8) = (0.12 x Column 2 x Column 4) + (0.06 x Column 3 x Column 5).

Example:

Figure 5.8 Residual Available Nitrogen from Previous Manure Application

Field	Manure Applied		Organic-N Content of Manure		Residual-N kg/ha
	1 year ago tonne/ha	2 years ago tonne/ha	1 year ago kg/tonne	2 years ago kg/tonne	
1	38	0	4.9	0	22.3
2	0	45	0	6	16.2
3	22	0	6.3	0	16.6
4	0	0	0	0	0
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6

Field 1

Residual N = (0.12 x 38 x 4.9) + (0.06 x 0 x 0) = 22.3 kg/ha.

Field 2

Residual N = (0.12 x 0 x 0) + (0.06 x 45 x 6) = 16.2 kg/ha.

Field 3

Residual N = (0.12 x 22 x 6.3) + (0.06 x 0 x 0) = 16.6 kg/ha.

Field 4

Residual N = (0.12 x 0 x 0) + (0.06 x 0 x 0) = 0.

STEP 6: Determine field and AOPA limitations.

It is important to determine field and AOPA limitations before applying manure:

- Slope.
- Proximity to water body and connecting streams.
- Nitrate-Nitrogen limits in AOPA.
- Distance from manure storage (hauling distance).

Example:

Figure 5.9 Field Characterization

Field	Distance (km)	Limitations	AOPA Limitations
1	4.8	Slope 6%	With incorporation within 48 hours, 30 m away from a common body of water or well.
2	6.4	Slope 4% and connected to a surface water body.	With incorporation within 48 hours, 30 m away from a common body of water or well.
3	8	Forage	If less than 4% slope, must be 30 m away from a common body of water or well.
4	0.5	None	With incorporation within 48 hours, 30 m away from a common body of water or well. Based on soil tests, if this soil was present in the Brown Soil zone, the nitrate-nitrogen content would be over the allowable limit and no manure could be applied to this field.



STEP 7: Field prioritization.

This is where information is integrated to determine accurate rates, which optimize economic return and minimize nutrient loss to the environment.

Example of factors to consider:

- The slopes in Fields 1 and 2 are steeper than the slopes in Fields 3 and 4; therefore, manure application should take phosphorus into consideration.
- The cost of hauling manure to Fields 2 and 4 might be relatively high; therefore, the manure pile or storage having the highest phosphorus nutrient content should be used.
- Field 3 is pasture; therefore, incorporation is not an option. Thus, application should be based on phosphorus.

Calculation of application rate for each field:

Field 1:

Due to the high slope, this field's manure rate will be based on phosphorus.

Table 5.6 shows the phosphate recommendation is 35 kg/ha.

- **If manure from Lot 1 is to be used:**

If manure is to be applied on P basis:

Manure application rate for Phosphate = [Phosphate Requirement (Figure 5.6) ÷ [Available Phosphate in manure]

Manure application rate based on P₂O₅: Manure rate = 35 ÷ 1.3 = 26.9 tonne/ha.

Crop available N = (Available N x Rate of Application) + Residual N

Crop available N = (3.9 x 26.9) + 22.3 = 127.2 kg/ha.

Fertilizer N to be added = [recommended amount (Table 5)] - [amount provided by manure, which is crop available]

Fertilizer N to be added = 180 - 127.2 = 52.8 kg/ha.

If manure is to be applied on N basis:

Manure application rate for N = [N Requirement (Table 5.6) - Residual N ÷ Available N in manure]

Manure application rate = (180 - 22.3) ÷ 3.9 = 40.4 tonne/ha.

Therefore:

Phosphate applied would be = 40.4 x 1.3 = 52.5 kg/ha.

This rate will result in an excess application of 17.2 kg/ha (52.5 - 35) of phosphate. The steep slope in this field means there would be a high risk for phosphorus runoff. Therefore, it is not recommended to base the manure application on N.

- **If manure from Lot 2 is to be used:**

Manure application rate = 35 ÷ 0.8 = 43.8 tonne/ha.

Crop available N = (2.4 x 43.8) + 22.3 = 127 kg/ha.

Fertilizer N to be added = 180 - 127 = 53 kg/ha.

For Field 1, using manure from Lot 1 or 2 makes a big difference on the rate of manure application. It is recommended to apply manure from Lot 1 (high nutrient content) because of hauling costs. Save manure from Lot 2 for fields that are closer to the manure storage.

Field 2:

Due to the steep slope and the field's close connection to a surface water body, the manure rate should be based on phosphorus.

Figure 5.6 showed a phosphate recommendation of 35 kg/ha.

- **If manure from Lot 1 is to be used:**

Manure application rate = $35 \div 1.3 = 26.9$ tonne/ha.
 Crop available N = $(3.9 \times 26.9) + 16.2 = 121.1$ kg/ha.
 Fertilizer N to be added = $110 - 121.1 = -11.1$ kg/ha.
 Therefore, the addition of mineral fertilizer is not needed.

- **If manure from Lot 2 is to be used:**

Manure application rate = $35 \div 0.8 = 43.8$ tonne/ha.
 Crop available N = $(2.4 \times 43.8) + 16.2 = 121.3$ kg/ha.
 Fertilizer N to be added = $110 - 121.3 = -11.3$ kg/ha.
 Therefore, the addition of mineral fertilizer is not needed.

For Field 2, using manure from Lot 1 or 2, the rate of manure application based on phosphorus will supply nitrogen requirements. It is recommended to apply manure from Lot 1 (high nutrient content), which allows lower application rate, therefore low hauling costs.

Field 3:

This field is on pasture; manure rate should be based on phosphorus.

Figure 5.6 shows a phosphate recommendation of 65 kg/ha.

- **If manure from Lot 1 is to be used:**

Manure application rate = $65 \div 1.3 = 50$ tonne/ha.
 Crop available N = $(3.9 \times 50) + 16.6 = 211.6$ kg/ha.
 Fertilizer N to be added = $190 - 211.6 = -21.6$ kg/ha.
 Therefore, the addition of mineral fertilizer is not required.

- **If manure from Lot 2 is to be used:**

Manure application rate = $65 \div 0.8 = 81.3$ tonne/ha.
 Crop available N = $(2.4 \times 81.3) + 16.6 = 212$ kg/ha.
 Fertilizer N to be added = $190 - 212 = -22$ kg/ha.
 Therefore, the addition of mineral fertilizer is not required.

For Field 3, using manure from Lot 1 or 2, the rate of manure application based on phosphorus will supply the nitrogen requirement. It is recommended to apply manure from Lot 1 (high nutrient content), which allows for a lower application rate, therefore lower hauling costs.



Field 4:

This field has no landscape proximity limitations. However, based on soil tests, if this soil was present in the Brown Soil zone, the nitrate-nitrogen content would be over the allowable limit and no manure would be allowed to be applied to this field. See AOPA, Part 1, Nutrient Management.

Figure 5.6 shows a nitrogen recommendation of 55 kg/ha.

- **If manure from Lot 1 is to be used:**

Manure application rate based on N = $(55 - 0) \div 3.9 = 14.1$ kg/ha.

Crop available P = $1.3 \times 14.1 = 18.3$ kg/ha.

Fertilizer P to be added = $45 - 18.3 = 26.7$ kg/ha.

Therefore, 26.7 kg/ha of phosphate is needed as mineral fertilizer.

- **If manure from Lot 2 is to be used:**

Manure application rate = $(55 - 0) \div 2.4 = 22.9$ tonne/ha.

Crop available P = $0.8 \times 22.9 = 18.3$ kg/ha.

Fertilizer P to be added = $45 - 18.3 = 26.7$ kg/ha.

Therefore, 26.7 kg/ha of phosphate is needed as mineral fertilizer.

For Field 4, using manure from Lot 1 or 2 makes no difference. However, it is recommended to apply manure from Lot 2 (if low nutrient content then use higher rate) because Field 4 has a relatively low hauling distance.

STEP 8: Manure and fertilizer needs per field.

Figure 5.10 Nutrient Summary: Needs and Balance

Field	Acreage ha	Application Rate			Total Application		
		Manure tonne/ha	Fertilizer kg/ha		Manure tonne/field	Fertilizer kg/field	
			N	P ₂ O ₅		N	P ₂ O ₅
1	40	26.9	52.8	0	1,076	2,112	0
2	121	26.9	0	0	3,255	0	0
3	40	50	0	0	2,000	0	0
4	162	22.9	0	26.7	3,710	0	4,325
				Total	10,041	2,112	4,325
				Balance*	+3,655	-2,112	-4,325

*Total manure in storage estimated as 13,696 tonnes.

*Manure Balance: After application, manure remaining will be approximately 3,655 tonnes.

Fertilizer needs are:

- 2,112 kg of nitrogen.
- 4,325 kg of phosphate.

6.0 PREVENTING AND SUPPRESSING FEEDLOT ODOUR

Preventing and suppressing odour from feedlots is a combination of good design, conscientious management and attention to detail. In reality, no feedlot will ever be odour-free, so the management objective is to avoid severe odour events by anticipating the conditions that give rise to extreme emissions.

To a great extent, feedlots are at the mercy of the weather with respect to odour potential, far more so than roofed or enclosed livestock operations. In general, the key to feedlot odour prevention is to keep manure and water separate whenever possible. This can be accomplished through thoughtful site selection, good feedlot design and proper management of corrals, manure storages and runoff catch basins.

Suppressing odour involves taking advantage of favourable weather conditions when performing highly odorous activities, responding quickly to adverse weather conditions and applying corral amendments when appropriate. Understanding that feedlot odour results almost exclusively from anaerobic conditions in manure is central to anticipating and mitigating odour.

The most important principle of odour control is to avoid anaerobic conditions by:

- Keeping manure and other organic materials dry.
- Keeping manure storages and surfaces exposed to oxygen.
- Keeping corral surfaces hard, smooth and free of loose manure.

6.1 Site Selection and Facility Design

Odour management is first and foremost an issue of site selection. Operators that anticipate building or expanding feedlots should avoid locations where neighbours are within one or two kilometres downwind. If expanding an existing operation or building a new feedlot, contact the Natural Resources Conservation Board (NRCB) and review Schedule 1 of the

Agricultural Operations Practices Act (AOPA), to determine the required minimum distance separation (MDS). This setback distance, from the outside walls of neighbouring residences to the point closest to the developing livestock facility, manure storage, runoff catch basin, compost area, feeding pen or barn, is designed to reduce odour nuisance.



6.2 Corral Design

Many existing feedlots already have well designed corral facilities that reduce odour, either directly or indirectly. In preparing an odour management plan, operators should consider the following design criteria:

Slope. The corral slope should be between two and four percent, sloping down away from the feed apron. A slope of two to four percent will shed rainfall more rapidly than a flat corral, reducing the likelihood of puddles that can quickly become anaerobic. Avoid too steep a corral slope, since it may result in soil movement (erosion) in the runoff water.

Drainage. Minimize pen-to-pen drainage of rainfall runoff. Corrals that drain discreetly and directly into a runoff are less likely to detain water behind the manure ridges that develop under fencelines between corrals.

Equipment access. Ensure manure pen cleaning equipment has convenient access to the corrals. Frequent manure removal is vital to ensure rapid, complete drainage. If equipment access is difficult or awkward, the corral surface will be difficult to manage.

Soil. Corral soils should be firm, stable and not easily eroded into rills and gullies. Eroded corrals are prone to water retention.

Fill. Ensure an abundant and convenient supply of fill dirt is available. When gouging or erosion occurs in a corral, rapid maintenance reduces the likelihood of puddles forming from rainfall or spilled drinking water.

Pen shape. Pen shape must be conducive to edge-to-edge manure removal. Pens that are irregularly shaped cannot be maintained in the hard, smooth conditions that are central to effective manure removal.

Drainage channels. The potential for backwater from major drainage channels should be low. In some older feedlots, the downstream edges of the corrals are prone to temporary flooding. Stagnant water in a corral is a major contributor to intense odour. Ensure that runoff channels are well maintained to prevent backwater, especially within corral boundaries.

Diversions. Clean rainfall runoff must be diverted around corrals and manure storages. This relieves pressure on the catch basin and reduces the amount of water that is potentially detained on the corral surface or around the base of manure stockpiles.

Figure 6.1



Pen-to-pen drainage can result in localized wet areas where drainage is incomplete, resulting in significant odour emissions.

Photo credit: Dr. Brent Auvermann, Texas A & M University

Figure 6.2



Fill dirt is frequently needed around concrete pads where water fountains are located.

Photo credit: Dr. Brent Auvermann, Texas A & M University

6.3 Feedlot Operation and Maintenance

Corral maintenance

No matter how well an open-lot feedlot has been designed, corral maintenance will make or break the yard with respect to odorous emissions. Again, the key is to keep the corral surface hard, smooth and dry, maintaining a firm two to five centimetre base of compacted manure above the mineral soil. Corrals that shed water rapidly and completely have the least potential for odour. The key elements of an odour management plan are:

Frequent, proper manure removal. In feedlots, manure removal typically occurs only after each corral is emptied for slaughter or transfer, an interval of 120 to 180 days. In flat feedlots or where ponding of rain is common, an interval of 120 days or more between manure removal activities will lead to corral conditions that are prone to odour. A few modern, large (capacity greater than 35,000 head) feedlots in Texas have experimented with continuous manure removal in which two or three tractors with box scrapers operate continuously across the yard, even when cattle are present. These corral conditions are excellent, and managers report little to no depression in feed-to-gain performance or increased cattle stress.

“Pull” blade vs. “push” blade. It is physically more difficult for a pushed scraper blade (e.g., front-end loader) to leave an even, smooth surface than a pulled blade (e.g., box scraper). Blades that gouge and scar the corral surface reduce the corral’s water-shedding efficiency.

Operator training. Train employees both in the techniques of manure removal and in the justification, motivation and objectives of manure removal. Machinery operators who understand both the “what” and the “why” will be more apt to make sound decisions.

Corral drainage. Frequent inspection for and correction of pits, holes and wallows is necessary. Train and equip bunk readers, feed-truck drivers, pen riders and night security providers to note pits and holes developing in the corrals. Repair corral damage with compacted fill. Assign higher priority to holes and wallows near water troughs and feed aprons, where spilled and excreted water may collect even during dry weather.



Manure mounds for flat corrals.

Construction of manure mounds serves a fourfold purpose:

- Temporary storage of excess manure.
- Cattle refuge from muddy, wet and cold conditions.
- Shade during the summer to reduce heat stress.
- A means to enhance the water-shedding efficiency of corrals with little or no slope.

Waterer maintenance. Pay rigorous attention to overflow waterers, misters and water distribution systems. Water leakage in corrals, near feedbunks and manure storage

areas can contribute significantly to odour. Train feedlot employees to look for signs of leaky distribution systems and water troughs.

Inspect fence lines. Ensure frequent inspection of fencelines for manure ridges, especially before rainfall. The moist manure that builds up under fencelines as a result of hoof action is a fertile breeding ground for flies. During rainfall these ridges act as dams, creating puddles and wet spots that generate odours. When rainfall is expected or when flies are becoming a major nuisance, knock down these ridges and spread the manure out to dry.

6.4 Drainage Structures and Runoff Catch Basins

Management of catch basins and other wastewater retention structures has been covered in great detail in Section 3. This simple checklist fills in some gaps concerning runoff control structures.

Open channels. Attend to corrals, settling basins and open channels to prevent clogging, backwater or poor drainage.

Equipment access. Where settling channels are used to reduce solids loading in catch basins, ensure that machinery for solids removal has convenient access under all weather conditions.

Sludge. Consistent monitoring and timely removal of excess sludge will improve catch basin performance and reduce odour potential.

Shallow catch basins. Shallow catch basins less than 1.2 metres (use natural topography where feasible), are less prone to anaerobic activity. This design option is probably not feasible in high-rainfall areas.

Drain water. When weather permits, pump out catch basins soon after storm events.

6.5 Mortality Management

Often overlooked, mortality management is one area in which public awareness has been sharpened by unfortunate, and often uncharacteristic, oversights or neglect.

Remove carcasses. Remove and dispose of carcasses quickly, especially in warm weather (Section 8).

Short-term storage. Locate short-term mortality storage (less than 48 hours) away from the property line and out of sight.

6.6 Manure Stockpiles and Composting Operations

Avoid long-term stockpiling of manure (over six months). Unmanaged stockpiles will eventually exclude oxygen and even if the stockpiles themselves are not odorous, old, stockpiled manure releases more odour when applied to land than manure that has been exposed to oxygen. If stockpiling is necessary, minimize stockpile size.

Avoid overheating. If stockpiling is necessary, ensure manure is dry (less than 45 percent moisture) to avoid overheating. Charred stockpiles release intense and uniquely disagreeable odours during application.

Locate properly. Locate stockpiles and composting operations upwind relative to prevailing winds and the centre of the feedlot. The odour potential of stockpiles and storage areas dictates that they should be situated as far upwind of the principal downwind property line as permitted by topography or other

operational considerations. Short-term solid manure must not be stored less than 150 metres from the nearest residence that is not owned or under the control of the feedlot (AOPA).

Provide supplemental carbon for composting. A proper carbon to nitrogen ratio in a compost pile or windrow encourages faster composting and reduces odours over the long term. (Section 4)

Aerate. Aerate compost piles at a frequency appropriate to their moisture content and composition. In general, aerate wet manure at two-day intervals until the moisture content is reduced to 65 percent or less, then aerate weekly or bi-weekly thereafter. High moisture content will reduce the oxygen content of the pore spaces in a compost pile. (Section 4)

Select drier manure for land application. Dry manure spreads more uniformly than moist manure and releases less odour.

6.7 Feeding Strategies

Recent experimental feeding strategies have been shown to reduce emissions of odorous compounds. With the sheer number of such compounds, it is unlikely that feeding strategies alone will reduce feedlot odour. However, it has several promising components for an overall odour management plan.

Nitrogen balance. Of the more than 170 compounds known to contribute to livestock odour, many contain nitrogen and/or sulphur. Balancing the ration with respect to nitrogen may help to reduce the amount of nitrogen excreted in manure and urine. This will not eliminate odours, but it has economic value and contributes to a conscientious odour-management regime.

Sulphur balance. Avoid overfeeding sulphur and account for dissolved sulphate in drinking water. The same principles apply for sulphur as for nitrogen. In addition to feedstuffs, excess sulphur may unwittingly be “fed” in the form of high-sulphate drinking water. Be aware of high-sulphate water and account for the additional sulphur when formulating rations.

Investigate innovative feeding strategies (cyclical rations, grouping methods). Although these strategies still await conclusive verification with respect to feed-to-gain efficiency, any feeding strategies that result in more efficient nutrient use should also reduce nutrient excretion and may improve overall profitability.

6.8 References

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6.9 Appendix: Health Effects of Odour from the Feedlot

People experience odour continually, even in the absence of livestock. During the course of a day, people are confronted with odour from asphalt during paving activities, perfumes and deodorants used by co-workers or gasoline vapours at the service station. People may use their sense of smell to judge the freshness of produce or meat at the grocery store or to assess danger from bears, skunks or other wildlife during a backcountry expedition. Recurring or persistent odours, especially if intense or disagreeable, may affect an individual's health, mood or sense of well-being.

Although the health effects of emissions from swine and poultry facilities have been studied extensively, not a great deal is known specifically about how feedlot odour affects human health. The primary reason for this species-specific knowledge base appears to be that swine and poultry are most frequently produced in houses or sheds where employees are exposed to unnaturally elevated odour concentrations and where natural ventilation is usually insufficient to reduce indoor concentrations. However, public and occupational health inquiries, along with the increased frequency of nuisance complaints, have increased scrutiny of confined feeding operations (CFOs), irrespective of the species being produced.

Feedlots, with their relatively large surface area, may generate large downwind plumes of odorants having some known association with human health effects. Although the evidence linking these odorants to public health is often circumstantial, evidence of occupational health effects is reasonably compelling and should be considered seriously. Emissions from non-CFO (industrial) sources should also be considered.

Odours vs. odorous compounds

Feedlot odour results from the interaction of a complex mixture of odorous compounds with an array of sensory receptors in the human body. Nearly 200 individual compounds emitted by livestock or livestock manure have been associated with measurable odour responses in humans. The profile of compounds

associated with livestock odour is likely to be species-specific because of differences in physiology and diet composition, but these compounds can be broadly classified in a manner that may be generally applied to all livestock species:

- Volatile organic acids.
- Trace sulphurous compounds.
- Trace nitrogenous compounds.
- Phenolic compounds.
- Alcohols, ketones and aldehydes.

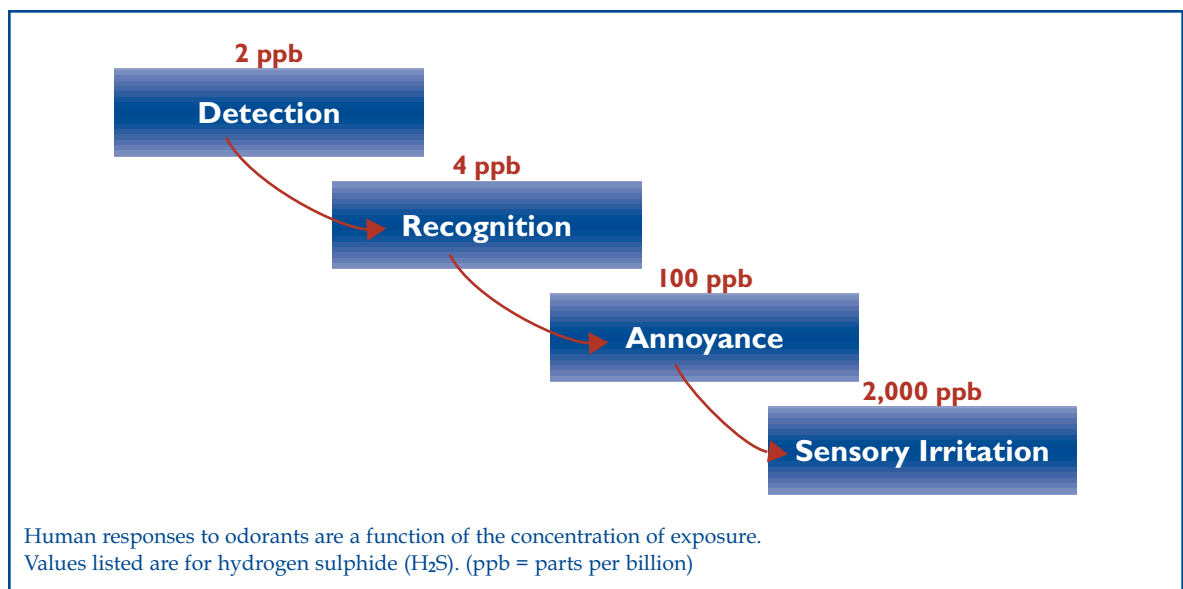
A key distinction exists between the health effects of exposure to feedlot odours and exposure to compounds associated with feedlot odour. In the former case, health effects are principally psychological and relate to the overall sensation of odour, which may depend strongly on conditioning, experience and cultural factors. In the latter case, however, human health effects are more clearly physiological and may frequently be linked to identifiable modes of action (e. g., asphyxiation or bronchoconstriction). Psychologically, significant odour responses often occur at concentrations well below physiologically significant levels. Of course, physiological and psychological effects are not entirely independent and may be mutually reinforcing. In both cases, the combined effects of multiple odorants may be additive, synergistic or antagonistic.

How humans perceive and respond to odours and odorous compounds

Research has described human response to odour and odorants in the context of two primary sensory systems, the *olfactory* and *trigeminal* systems. The dominant system that operates in response to a given compound or mixture of compounds depends on the concentration(s). As concentrations increase, human responses proceed through benchmarks of detection, identification or recognition, annoyance and irritation, as shown in Figure 6.3.

Figure 6.3

Human Responses to Odorants



Reference: Dr. Brent Auvermann, Texas A & M University

The detection threshold of an odorant is its concentration in air, at which 50 percent of human panelists in a test are able to detect the presence of the odour correctly without recognizing the odorant specifically. In general, each panelist is presented with two or more streams of air, one of which has the odorant at a known concentration. The other stream(s) is so-called “odour-free” air, which usually has been deodorized by drying the air and passing it through a filter of activated charcoal or other adsorbent media.

The panelist must blindly choose which of the streams of air contains the odorant. The 50 percent (median) response criterion reduces the influence of hypersensitive and hyposensitive panelists (panelists whose ability to detect the presence of odour is consistently well outside the normal range) in determining detection thresholds.

Physiological responses to odorants

With so many different classes of compounds contributing to livestock odour, human physiological responses to odorants are many and varied. Even different compounds within a class of odorants or different isomers of the same compound may produce different

physiological (either health or olfactory system) responses. The following section explores the major odorant classes and their most extensively documented dose-response characteristics. For comparison, typical occupational exposures and ambient concentrations are presented where published data is available.

Ammonia and hydrogen sulphide

Although research surveys of gaseous emissions from feedlots are in their infancy, ammonia (NH₃) and hydrogen sulphide (H₂S) are likely to dominate the emissions profile in terms of total mass emitted. The hedonic tones (what the odour smells like) of NH₃ (glass cleaner), and H₂S (rotten eggs), are distinct and widely recognizable. Although these compounds are undeniably odorous, studies show concentrations of NH₃ and H₂S in ambient air to be unreliable predictors of the intensity of livestock odour as perceived by human panelists.

Ammonia (NH₃). Although European researchers have studied NH₃ releases from livestock facilities for some time, only recently has North American attention turned to NH₃ release as it pertains to odour, and secondary particulate matter formed through combination with atmospheric nitrate and sulphate ions.

As an odorant, the public overrates the potency of NH₃, perhaps because it is present almost everywhere and because of its relatively high concentration in air compared to other odorants associated with livestock production. Research demonstrates that at concentrations up to 20 ppm, NH₃ is an eye irritant. Studies have shown that at concentrations between 40 and 200 ppm, exposure symptoms include headache, nausea, appetite suppression and upper respiratory irritation.

The odour detection threshold of NH₃ is approximately 5 ppm, and its one-hour exposure guideline in Alberta, which is clearly not a health-based threshold, is 2 ppm. In 1998-99, Alberta Environment measured one-hour NH₃ concentrations downwind of CFOs ranging from 0.011 ppm to 1.364 ppm (Alberta Environment, 2000). Average one-hour concentrations downwind of the eighteen CFO locations ranged from 0.009 ppm to 1.213 ppm.

Hydrogen sulphide (H₂S). H₂S is among the most well known occupational hazards for individuals working in the confined livestock industry. Denser than air, H₂S accumulates near (or below, in the case of manure pits) the floor in enclosed livestock barns. Workers may encounter lethal concentrations of H₂S when manure pits are agitated and pumped out. It is an irritant at concentrations between 2 and 20 ppm (well above its detection threshold of 2 ppb) and induces nausea between 50 and 100 ppm. At concentrations above 200 ppm, H₂S may cause dizziness, susceptibility to pneumonia and fluid in the lungs. It has been shown that extreme concentrations (greater than 500 ppm) are potentially lethal within seconds. At those concentrations, H₂S may paralyze the nasal nerve cells so that the person is unable to smell the gas and escape danger. Research reports 600 ppm as the H₂S threshold where rapid death is likely.

As an example of typical occupational exposures in mechanically ventilated, deep-pit swine barns, research measured daily average H₂S concentrations between 38 and 536 parts per billion (equivalent to 0.04 to 0.5 ppm), with 12 minute averages up to 1.6 ppm, one-sixth of Alberta's eight hour Occupational Exposure Limit (OEL) of 10 ppm. One hour averaged H₂S concentrations downwind of Alberta feedlots and swine facilities ranged from below the minimum detection limit of 0.6 ppb to 54 ppb; the mean one-hour measurement was 4 ppb. Alberta's one-hour guideline for H₂S, 10 ppb, is based on odour perception, not human health.

Remarkably, among the eighteen CFOs in the Lethbridge area, where downwind H₂S was measured in 1998 and 1999, maximum one hour concentrations exceeding the 10 ppb odour-based guideline were observed at two locations only (26 ppb and 54 ppb). In both cases, these one hour spikes were 0.5 percent or less of the eight hour OEL and were located within 30 metres of the source of the swine facilities.

With notable exceptions (associated mainly with agitation and pumping of stored, liquid manure), livestock production does not appear to elevate environmental H₂S or NH₃ concentrations as individual compounds to levels that would compromise occupational or public health in the strict physiological sense. The synergistic or antagonistic effects on human health that these two compounds may have with trace gases are unknown.

Trace gases

Other than H₂S and NH₃, the other gases and vapours typically associated with odour from manure decomposition are *trace gases*; that is, when detected in livestock odour, they occur in quantities too low to be considered serious physiological threats to human health. At high concentrations (i.e., far beyond the concentrations detected downwind of livestock facilities), many of these compounds are considered extremely hazardous substances for selected regulatory purposes and emergency planning (e.g., spills). These compounds, as well as H₂S and NH₃, are not unique to livestock agriculture and are emitted in significantly greater quantities from heavy and light industry than from CFO.

Trace gases tend to have low odour thresholds so that even when their concentration in air is minute, they may affect the sensation of odour and thereby contribute either indirectly to physiological health effects or directly to psychological effects. The classes of compounds that tend to be trace gases are often characterized by distinct hedonic tones, although individual compounds may differ in hedonic tone from that of the class as a whole.

Volatile organic acids - "Sour." Volatile organic acids (VOAs), including volatile fatty acids (VFAs), occur in trace amounts but appear to serve as reliable indicators of odour intensity. Remarkably, even compounds in this class which are as seemingly harmless as acetic acid (vinegar) are considered hazardous substances in the context of emergency planning regulations.

Phenolic compounds – “Medicinal.” As measured by their odour thresholds, phenol, p-cresol and their isomers are among the strongest odorants associated with livestock manure. Like many of the trace odorants, phenolics can be extremely hazardous at high concentrations, but are detectable many orders of magnitude below their hazardous thresholds.

Alcohols, ketones and aldehydes – “Sweet” or “Pungent.” This broad class of compounds represents many common by-products of industrial fermentation. Ethanol, for example, is a sweet-smelling alcohol produced by bakeries, breweries and distilleries. N-butanol, another sweet-smelling alcohol, is a standard reference odorant used in olfactometry. These gases are upper respiratory irritants and/or ocular irritants at high concentrations.

Trace sulphurous compounds – “Rotten.” Trace sulphurous compounds include assorted mercaptans, sulphides and other by-products of protein metabolism. Butyl mercaptan, for example, is the compound primarily responsible for skunk odour.

Trace nitrogenous compounds – “Fishy or Pungent.” These compounds, which include the amines and methylamines, are among the most prominent odorants associated with CFOs. Like the trace sulphur compounds, they are by-products of protein metabolism, and many are considered extremely hazardous at concentrations far higher than those routinely encountered near CFOs.

Odours, psychology and quality of life

Medical scientists have studied the psychological aspects of odour exposure extensively over the past decade. CFOs are not the only source of environmental odours in rural areas. In particular, chemical and petrochemical industries, oil and gas production, agricultural processing facilities and other industrial sources may contribute significantly to rural odour loads. Vehicle traffic on major highways may also contribute in localized areas. Where CFOs are large and/or numerous, however, their contribution to nearby odour loads is difficult to dispute.

Of course, odour is often an excellent advance indicator of an imminent health hazard and can therefore be useful and desirable

property. For example, utilities add a trace odorant to odourless methane gas (CH_4) so that homeowners can detect leaks, faulty pilot lights or kitchen appliances that are accidentally left on. Although high concentrations can paralyze the olfactory system, the odour associated with low concentrations of H_2S can provide advance warning that dangerous conditions are possible, imminent or nearby.

Epidemiological literature only vaguely supports the assertion that the psychological impact of odours induces direct significant physiological effects *per se*. Much of the literature focuses on mood disturbance, impaired quality of life, and health surveys based on self-diagnosis and symptom reporting by respondents in the vicinity of CFOs. In many cases, such surveys are not accompanied by direct exposure or ambient air quality data from which intensity/response relationships can be inferred.

Nevertheless, despite a lack of epidemiological data and evidence of direct causality, the association between geographical regions of CFO concentration and mood disturbance, impaired quality of life and increased stress, represents a reasonably compelling, circumstantial case that CFO odour plays an important role in both the psychological health and physical well-being of the surrounding community.

Research has involved a respected survey instrument known as the *Profile of Mood States* (POMS), which has been used frequently and with good reproducibility in a variety of psychological contexts completely unrelated to the sensation of agricultural odours. (For example, the POMS instrument has been applied to athletic performance, post-surgical recovery and pleasant odours.) Briefly, the experimental design consisted of:

- 44 residents of North Carolina were sampled in each of two groups (control and experimental).
- The majority of respondents were skilled labourers.
- Experimental respondents lived near hog operations.
- Experimental respondents took the POMS on four different occasions when odour was present.
- Control respondents took the POMS on two different occasions.

Respondents answered questions that were linked to six major indicator classes of mood: tension, depression, anger, vigour, fatigue and confusion. Responses within each indicator class were combined to yield a single score for that class as shown in Figure 6.2. Although the six indicator classes do not appear to be purely independent of one another, the authors computed a weighted sum of the individual indicator scores (weighting “vigour” negatively) to yield a Total Mood Disturbance (TMD) score.

All of the indicator scores differed significantly and although the probable correlation of certain indicator pairs renders the TMD score suspect as an aggregate measure of the overall degree of impact, the proximity of CFOs appears to have a measurable effect on overall mood. To the extent that mood or its indicators induce or intensify physiological responses to stress (e.g., hypertension, hormonal responses), CFO odours may be thought to affect human health in a measurable way.

Some research has gone further, suggesting that the use of liquid manure management systems (as compared to a pasture operation) significantly increased the incidence of the following symptoms of reduced quality of life:

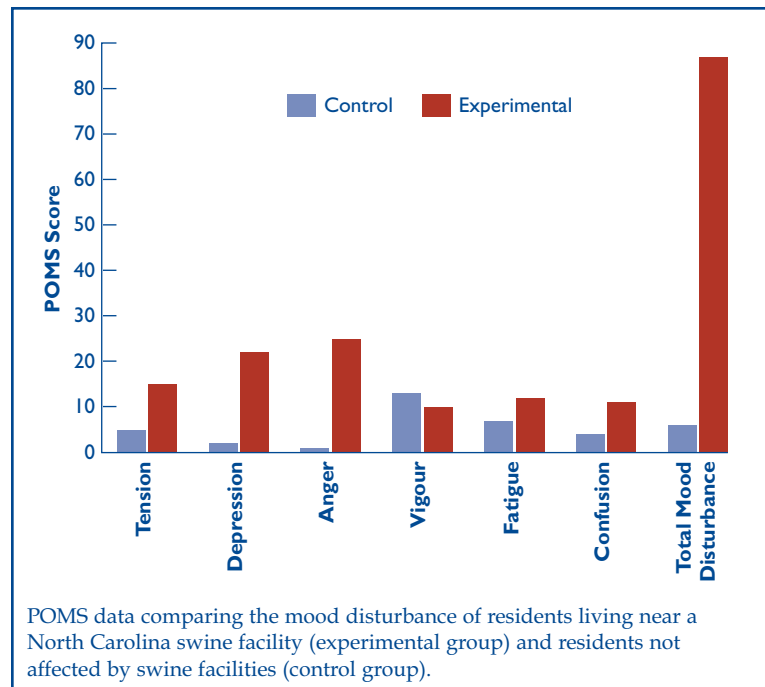
- Being reluctant to open the windows or go outside.
- Reports of headache, runny nose and/or sore throat.
- Excessive coughing.
- Burning eyes.

Three North Carolina communities near livestock operations were examined under winter conditions (January-February 1999). The nearby livestock production consisted of:

- One 6,000-head swine finishing facility.
- Two dairies with a total milking herd of 300.
- One unconfined livestock area with no liquid manure management system.

Figure 6.4

Association Between Geographical Regions and Mood Disturbance



Reference: Schiffman, S., Brain Research Bulletin 1995; 37(4): 369-375.

The authors surveyed health symptoms and reduced quality of life in these communities in the context of generic “rural health” and did not identify livestock production as the focal point when recruiting participants. Individuals conducting the surveys did not notice odours on the dates they conducted the surveys, and the authors did not collect environmental exposure data, so no clear association exists between odour *per se*, and the physical and psychological symptoms reported. The nature of the psychological responses could suggest odour as the causative agent(s), but, as is the case with much of the survey data concerning the health effects of livestock odours, the conclusions were not buttressed with monitoring data, olfactometry, scentometry or other exposure measurements. The survey responses were also highly species-specific (i.e., ruminants vs. monogastrics).

In a similar study, eighteen respondents living within 3.2 kilometres of a 4,000-head swine facility and a control group of identical size were surveyed. They concluded that the two groups reported significantly different levels of respiratory symptoms: nausea, weakness, dizziness and fainting; headaches and plugged ears; and burning eyes, runny nose and sore throat. Interestingly, however, they found little evidence to suggest that either anxiety or depression was elevated in the CFO neighbours.

Summary

As the scale and intensity of commercial livestock production increases, odour is among the most contentious issues arising between livestock producers and their neighbours. Perhaps because of the inherent subjectivity involved in odour perception and the difficulty involved in associating measured odour intensity with nuisance odour events, research has yet to confirm consistent causal associations between CFO odour and clearly defined medical syndromes, illnesses or psychological responses. Still, the number of studies that have drawn statistical associations between geographical location and suites of self-reported symptoms will undoubtedly give rise to more detailed research to establish any causation that may exist. Although many of the chemical components of CFO odours are listed worldwide as hazardous to humans, they usually occur at concentrations far below human health thresholds.

Glossary of Terms

Additive, Synergistic and Antagonistic.

These terms refer to the ways in which the combined effect of two or more stressors may be expressed, and they are most easily defined by giving an example:

Suppose that pure ammonia gas at 10 ppb in air has an odour threshold of five, and pure hydrogen sulphide gas at 10 ppb in air has an odour threshold of five. Now, prepare a mixture of ammonia, hydrogen sulphide and air so that the ammonia concentration is 10 ppm and the hydrogen sulphide concentration is 10 ppb. The odour threshold of the mixture defines whether the effect of mixing the two is additive, synergistic or antagonistic.

- If the odour threshold of the mixture is 20, the effect is said to be additive; the effect of the mixture is equal to the sum of the effects of the individual, pure components.
- If the odour threshold of the mixture is, for example, three, the effect is said to be antagonistic; the effect of the mixture is less than the sum of the effects of the individual components.
- If the odour threshold of the mixture is, for example, 30, the effect is said to be synergistic; the effect of the mixture is greater than the sum of the effects of the individual components.

Asphyxiation. A potentially lethal medical condition in which the lungs are deprived of oxygen.

Bronchoconstriction. A medical condition in which the air passages (bronchial passages) in the lungs shrink or are squeezed, leading to partial or full asphyxiation.

Isomers. Two or more chemical compounds having the same chemical formula but whose physical structures are different. For example, ethanol ($\text{CH}_3\text{CH}_2\text{OH}$) and dimethyl ether (CH_3OCH_3) have the same total number of carbon, hydrogen and oxygen atoms in their molecular formulas, but differ in the way the atoms are joined together in their molecules. Isomers nearly always have different properties.

7.0 FEEDLOT DUST

7.1 Management and Design Key to Dust Control

Preventing and suppressing dust from feedlots is a combination of good design, conscientious management and attention to detail. The management objective is to avoid severe events by anticipating the conditions that give rise to extreme emissions. To a great extent, feedlots are at the mercy of the weather with respect to dust potential – more so, obviously, than roofed or enclosed livestock operations. In general, as with odour management, the keys to feedlot dust prevention are:

- Thoughtful site selection.
- Good feedlot design.
- Proper management of corrals and manure storages.

Suppressing dust involves:

- Reducing cattle activity when the manure pack's susceptibility to dust emissions is at its daily maximum.
- Reducing the quantity of dry, loose manure subject to hoof action.
- Managing the daily water balance to keep corral moisture in the optimum range of 25-45 percent.
- Reducing dust emissions on roads within the feedlot and on roads during pen cleaning and harvest/silage production.

7.2 Site Selection

Dust management is first and foremost an issue of site selection. Research suggests that individuals or companies who anticipate building or expanding feedlots should

carefully avoid locations where neighbours are downwind within a kilometre or two. Feedlots located at the tops of ridgelines and hills can take advantage of natural atmospheric mixing.

7.3 Open Lots

The influence of pen moisture on dust emissions from feedlots is both logical and well documented. In general, dust control strategies for open lots follow the same lines as odour control strategies with respect to corral management.

The well-known evening dust peak appears to result from three main factors. First, the afternoon heat, wind and solar radiation have driven off surplus moisture, leaving the manure pack drier than at any other time of the day. Second, cattle emerge from their typical afternoon lethargy and move to the feed bunk to drink or play. Third, with the atmosphere's tendency to become more stable between dusk and midnight, the manure particles suspended

Figure 7.1



Major dust events occur when dry, loose manure accumulates on the corral surface and is pulverized and suspended by hoof action.

in the air by cattle activity tend to remain near the ground, forming a “dust cloud,” which may persist well into the evening or early morning.

To avoid dust complaints from downwind neighbours, pay close attention to the amount of dry, uncompacted manure on the feedlot surface.

- Frequent, effective removal of loose manure from pen surfaces is one of the most important management practices for dust control. Good pen drainage is essential to effective manure removal.
- A corral slope of two to four percent will ensure that pens shed water rapidly. Frequent manure collection with equipment that leaves a compacted, smooth, uniform surface (box scrapers are excellent), will reduce dust potential dramatically.

Figure 7.2

Dust Generating Behaviours (agonistic behaviour, bulling and locomotion)

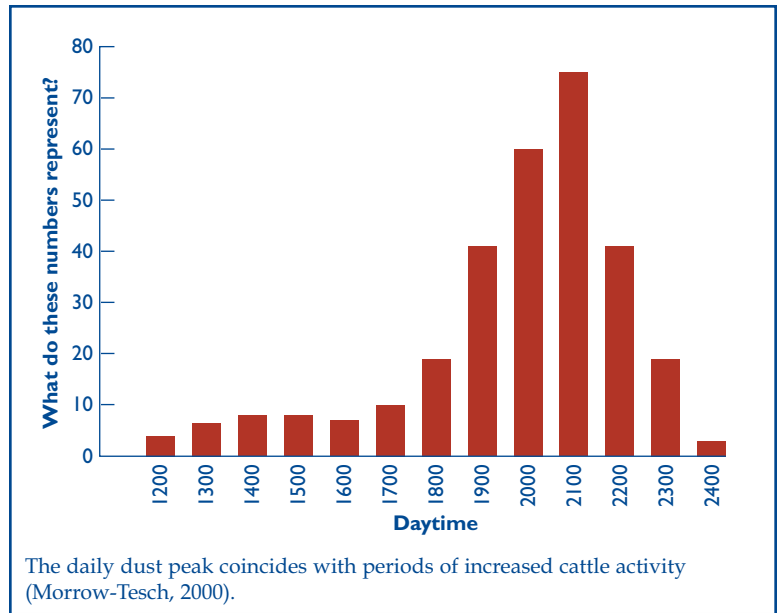


Figure 7.3



Frequent collection of loose, dry manure reduces the potential for major dust events.

Photo credit: Dr. Brent Auvermann, Texas A & M University

7.4 Corral Design

The same design principles for odour control also apply to dust control.

- Managing the corral surface for both odour and dust control is easiest and most effective when the pens do not accumulate moisture in small or localized areas. Pen areas that retain moisture are most likely to end up mushy, disturbing the firm two to five centimetre compacted layer that provides a solid base for operating manure removal machinery.
- There should be easy access for water trucks throughout the feedlot. In semi-arid and arid regions, application of supplemental moisture is often necessary to compensate for daily evaporation and maintain optimum moisture content on the corral surface. Feedlots that opt for water trucks (as opposed to sprinkler systems) should ensure that distribution pipelines across the facility put water where trucks will not be required to “dead-head,” or roll empty, over large distances. Water trucks can also be used to keep dust down on roads near the feedlot during harvesting (silage season) and pen cleaning.
- Corrals should be conducive to cross-fencing for stocking-density manipulation, if applicable. Dust control in regions with

moderate annual moisture deficits (e.g., semi-arid and temperate regions), may be improved by periodic adjustment of stocking density in existing pens. In research, stocking density increases of up to 100 percent (from 14 m²/head to 7 m²/head cattle spacing), have been shown to reduce downwind dust concentrations by up to 29 percent. Increasing the number of cattle per pen is one approach, but it reduces the linear bunk space available to each animal and may result in behavioral changes that increase stress and reduce livestock performance. As well, it may not necessarily be an odour suppressing technique (i.e., wetter pad in crowded conditions).

- A more plausible alternative is to install temporary (electric hot-wire) or permanent fences in suitable corrals, being careful to maintain convenient herd management and easy access by pen riders and machinery. Preliminary, unpublished evidence suggests that the behavioral effect of increased stocking density may be more significant in large (greater than 150 head) pens than in small (less than 100 head) pens, so managers should experiment with stocking-density manipulation cautiously and on a small scale.

7.5 Corral and Road Maintenance

In addition to those practices outlined for odour control, the following measures will help to reduce dust potential in corrals and on unpaved roads within and outside the feedlot boundary.

- Remove loose manure surface material in pens and alleys frequently. This improves manure quality for land application and reduces the amount of material exposed to hoof action. Maintain a compacted pen layer of manure two to five centimetres thick.
- Topical application of crop residues on corral surfaces is experimental. Top-dressing corral surfaces with organic residues from crop harvesting or processing may increase the moisture-holding capacity of the manure. In addition, the residue may provide a cushioning property that reduces the shearing effect of the hoof. No research

data yet exists to document the effectiveness of this technique. Candidate top dressings include straw, waste hay, cotton “gin trash” and peanut hulls. These carbonaceous additives may also increase the quality of the manure composting process.

- Topical application of chemical resins on dirt roads is experimental. Corral dust control is vastly different from road dust control because livestock are continually adding new material to the corral surface. As a result, topical treatments would appear to require frequent reapplication to be effective in the corrals. However, according to studies, applying expensive resins or petroleum derivatives to dirt roads appears to be effective in reducing dust from truck traffic.

7.6 Feeding Strategies

- Discouraging end-of-day spikes in livestock activity is experimental. Preliminary research data suggests that altering the feeding schedule from the industry norm may dramatically reduce cattle activity in the late afternoon and early evening. Although the method requires further validation, the concept has great theoretical merit.
- Modestly increasing the fat content of the ration is experimental. Slight excess fat in the ration may increase the cohesiveness or plasticity of the resulting manure, which makes the dried manure less susceptible to shearing. This method has not been conclusively evaluated in production-scale research and is likely to be expensive.

7.7 Other Technologies and Landscaping Options

- Solid-set sprinkler systems are an effective but expensive means of dust control in cattle feedlots. Research in California showed that in-corral dust concentrations increased 850 percent after sprinkler operation had ceased for two days. Sprinkler systems require considerable site-specific design based on seasonal water balance calculations, but in general terms, systems should have sufficient capacity to deliver 0.5 centimetre or more of water per day across the entire feedlot.
- Set sprinkler patterns to overlap by 50 percent of the diameter of throw and ensure the throw does not extend all the way to the feed apron. Sprinklers should cover all corners of the pen, and should also cover holding pens and alleyways. Draw water for sprinkler systems from a holding tank to avoid a demand peak on the main water system that may reduce drinking water delivery during the hot afternoon. Corral moisture between 25-45 percent, as a balance between dust and odour control, is ideal.

Figure 7.4

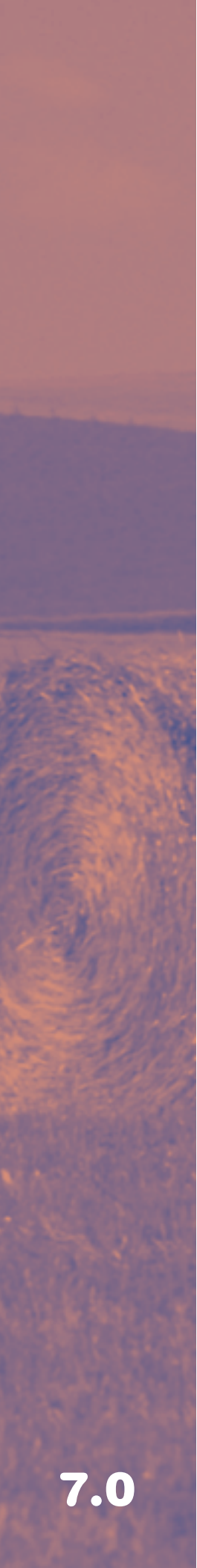


Solid-set sprinklers are an expensive but reliable means of reducing dust during peak dust season.

- Pens should have a firm, smooth and evenly-graded corral surface with two to five centimetres of compacted manure on top of the mineral soil. Box scrapers, or “pull” blades, do an excellent job and are often adjustable with respect to blade depth.
- Vegetative barriers may be used to increase dispersion by elevating dust-laden air from the ground surface and mixing it with cleaner air aloft. Fast growing trees also provide a visual barrier that may indirectly reduce nuisance complaints or improve relations with neighbours and passers-by.

7.8 References

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8.0 DISPOSAL OF FARM WASTE

8.1 Disposal of Dead Animals

Some death loss will occur on every feedlot, no matter how well they are managed. Disposing of dead animals quickly and effectively is important to reduce the risk of disease. It is also important in maintaining good neighbour relations. Carcasses can be a source of disease if scavenged by wildlife or pets. Some of these diseases can then be passed back to livestock or even humans. Carcasses are also an eyesore, a source of odour and can contribute to fly problems.

The current *Destruction and Disposal of Dead Animals Regulations* requires that all dead animals be disposed of within 48 hours by incineration, burying, rendering, composting or natural disposal (scavenging). Incineration and natural disposal (scavenging) may be used under very restricted circumstances described in the regulations.

A dead animal may be stored for more than 48 hours after death if it is stored:

- For not more than one week in an enclosed structure with impervious walls and floors that have been constructed for the storage of dead animals.
- Outside during winter months when the ambient temperature is low enough to keep the dead animal completely frozen.
- In a freezer unit.

There are restrictions on the use of composting, burial and natural disposal that must be followed in order to minimize the risk of disease spread and nuisance concerns. Composting, burial and natural disposal sites are all required to be specific distances from waterways, well sources, major roads, residences and parks. These sites must be on the producer's own property or property leased by the producer. For more information on these restrictions refer to Section 2 of this manual or the *Destruction and Disposal of Dead Animals Regulations* from Alberta Agriculture, Food and Rural Development (AAFRD).

Animals euthanized by drugs or those known to have died from infectious diseases (e.g. *Salmonella*), or reportable diseases must

not be disposed of by natural disposal. For more information, contact the local veterinarian.

Storage. Some operations use special storage bins, or refrigerate or freeze carcasses until they can be taken to a rendering facility. This reduces odour, keeps them out of sight and prevents scavenging. Dead animal storage areas should be located in areas that will minimize the spread of disease. In a feedlot, this may be a separate entrance different from the main entrance to the feedlot, which will prevent rendering trucks from entering the main feedlot and driving by offices, feedlot pens and feed storage areas.

Clean-up. Ensure storage areas are thoroughly cleaned after each pickup and that wastewater does not run into streams or other surface water.

Burial. Bury animals promptly to control odour, insects and scavenging. In the winter, during periods of intense cold, this may be difficult due to frozen ground. Be prepared to store the carcasses in a frozen state or have them picked up for rendering during these times. The burial pit area should be screened from view by trees, shrubs, square or round bales, or fences, and be located at some distance away from the feedlot. Burial pits should not be located where runoff could contaminate surface water and should not be located near wells or other water sources.

Other animal tissue waste, such as afterbirths and tissues from surgery (e.g. castration), can be disposed of as carcasses or sent to a landfill in a sealed plastic container or bag. Blood or blood products from animals can be safely flushed down the drain. For more information on livestock burial, refer to AAFRD Agdex 400/29-2.

Composting. For more information on composting dead animals, refer to:

Code of Practice for Compost Facilities under Waste Control Regulation A. R. 192/96.

Developed and administered by Alberta Environmental Protection.

Refer to the *Destruction and Disposal of Dead Animals Regulations* under the *Livestock Diseases Act*, for details on regulations pertaining to the disposal of dead animals and to Section 2 of this publication. A copy of these regulations may be obtained from an Alberta Agriculture, Food and Rural Development (AAFRD) office, or by visiting the AAFRD Web site at www.agric.gov.ab.ca/navigation/department/acts/index.html.

8.2 Disposal of Veterinary Waste

8.2.1 Sharps

Sharps are veterinary and laboratory materials capable of causing cuts or punctures. Sharps include needles, syringes, scalpel blades, slides, coverslips, pipettes, broken glass and empty or expired pharmaceutical containers. There is a risk of needle stick injuries or cuts when these materials are not handled or disposed of properly.

Certain drugs or vaccines may cause reactions or infections if they are present on broken glass or used needles that break the skin. Blood on used needles, collection tubes or other equipment, may contain viruses or bacteria that can cause illness following a cut or needle stick injury. Bacteria or viruses from blood on used needles are a potential disease risk in needle stick injuries. There are currently no regulations covering the disposal of sharps in agriculture.

To safely dispose of sharps:

Separate sharps from other waste. Injuries can occur while handling sharps at the feedlot or at the landfill, if staff are unaware of their presence, or if they are not in rigid containers. Disposal in plastic bags is unacceptable.

Use a labelled, rigid sharps container for disposal.

- For needles and surgical blades, use a rigid plastic or metal puncture-proof container

with a sealed lid. These special containers can be obtained from local veterinary clinics. Label clearly as “sharps containers,” and “not for recycling.” A plastic jug with a narrow mouth or a 20-litre pail with a narrow opening in the lid also works well. Injuries can occur if workers try to retrieve an object back out of the container, so containers should be narrow-mouthed or have well-sealed lids with a small hole. Ensure children or animals cannot remove the lid. Do not attempt to recap needles before disposal – this is a common cause of needle stick injury.

- For pharmaceutical bottles and syringes, use a pail or other rigid container.

Remove medical waste from the farm. Take pails of bottles and syringes and full containers of waste needles and surgical blades to the local vet clinic or hospital for disposal. Contact them first to ensure they accept these. There are also private companies that will pick up medical waste. Contact the local vet clinic or hospital for information. Labelled, sealed containers can also be taken to Class 2 landfills (which accept medical waste, have perimeter fencing, etc.).

Do not burn sharps containers.

8.2.2 Expired medicines

Regularly check all drugs for the expiry date. Expiry dates appear on the label as EXP 08 2000, for example, or as 24APR01. All drugs past the expiry date should be discarded, as product safety and efficacy can no longer be guaranteed. Medicines not past their expiry date sometimes need to be discarded as well.

Products such as vaccines must be handled carefully (e.g., refrigerated) to maintain efficacy. If in doubt about how a product has been handled and whether it is still safe or effective (e.g., vaccine left at room temperature overnight), consult a veterinarian.

On some vaccines, the label states “use entire contents when first opened.” The remaining vaccine should be discarded after vaccination is complete – consult a veterinarian.

There are two classes of expired medicines – unused (unopened) and used (opened).

Unused expired drugs can be returned to the point-of-purchase, such as the vet clinic. Many manufacturers will accept them for disposal. Used or expired drugs can be discarded the same way as sharps.

Modified-live virus vaccines should be rendered noninfectious before disposal to prevent the virus from potentially infecting workers or animals. This can be done by freezing, autoclaving, burning or adding bleach to the bottle. When disposing of either used or unused expired medicines, do not attempt to empty or wash bottles – discard them with their contents.

Every May in Alberta, veterinary clinics collect outdated medications. Consult with the local veterinarian to find out more about this program.

8.3 Disposal of Chemical Farm Waste

Chemical farm waste includes pesticides (herbicides, fungicides, insecticides, rodenticides), pesticide-treated seed and

topical parasiticides (pour-on or powders for treating parasites), cleaners, disinfectants and petroleum products.

8.3.1 Pesticides

For complete details on safe pesticide use and disposal, consult the *Crop Protection Manual* (Agdex 606-1), available from AAFRD

district offices or from the Publishing Branch, 7000 – 113 Street, Edmonton, Alberta, T6H 5T6.

8.3.1.1 Pesticide disposal

Unwanted or expired pesticides must be disposed of carefully. Pesticides are hazardous wastes and cannot be disposed of in sanitary landfills or by burning. Offer unused pesticide supplies to neighbours. Pesticides that have no further use must be disposed of as hazardous

waste. Names of companies that are licensed to handle hazardous waste can be obtained from Alberta Environment's Recycle Information Line at 1-800-463-6326. Unused products can also be returned to the dealer.

8.3.1.2 Pesticide storage

- Pesticides should be purchased on an as-needed basis and should not be stored on the feedlot for long periods.
- Read the label for specific storage instructions during temporary storage.
- Pesticides should be stored in a cool, dry place in the original containers. Keep pesticides from freezing and protect from excessive heat.
- A pesticide storage area should have an impervious floor with curbs, no floor drains, and be supplied with an overpack container and a supply of absorbent material, such as sand or kitty litter.
- Pesticides should not be stored:
 - Near feed, food or fertilizers.
 - In well houses or feed mixing and milling rooms.
 - Around the home and should be out-of-reach of animals and children.
- Pesticides should never be stored or mixed within 30 metres of an open body of water.
- Pesticides that are highly toxic to mammals, such as certain rodenticides and parasiticides, should be stored under lock and key.

8.3.1.3 Pesticide container disposal

Empty pesticide containers must be disposed of carefully. Unrinsed empty pesticide containers have the potential to contaminate ground and surface water and can be toxic to fish and wildlife. Under the *Alberta Environmental Protection and Enhancement Act*, non-refillable plastic or metal pesticide containers (restricted, agricultural and industrial products) must be disposed of at a pesticide container collection site.

A list of pesticide container disposal sites in Alberta is available from each municipality, in the *Crop Protection Manual*, or from Alberta Environment. Containers must be clean (triple rinsed or pressure rinsed) and well drained (dry) before disposal. In most cases, triple rinsing leaves plastic, metal or glass pesticide containers more than 99 percent free (less than 1 ppm) of residues. For details on rinsing, consult the *Crop Protection Manual*.

Paper bags and cardboard containers should be thoroughly emptied and disposed of in a sanitary landfill. Paper bags or cardboard

containers should not be burned. Outer packaging (e.g., cardboard boxes) may be burned or disposed of in a regular landfill. Some pesticide container sites have bins or separate areas for collecting outer packaging materials.

Containers from topical parasiticides, (e.g., pour-on compounds or powders for lice and mange) should be disposed of in a safe manner. These compounds can be toxic to fish, wildlife, other livestock and humans. These products should be kept out of waterways and streams and not be allowed to contaminate food or feed. Some products are controlled under the *Pest Control Products Act* and it is an offence to use them other than as directed on the label. Containers should not be reused and empty containers should be made unsuitable for reuse.

For specific information on the disposal of unused and unwanted product and the clean up of spills, contact the regional office of Conservation and Protection, Environment Canada.

8.3.2 Handling and disposal of petroleum products (fuels and lubricants)

Fuels and lubricants can be toxic to humans, livestock, wildlife and fish. Proper storage and handling at the feedlot is necessary to limit

risks to human and animal health and the environment.

8.3.2.1 Health and environmental risks

Gasoline and diesel fuel. In humans, skin contact with gasoline and diesel fuel can cause irritation or chemical burns, while breathing vapours can result in headaches, dizziness, and nausea. These products are possible causes of cancer. Spilled fuels will kill plant life and fish. Cattle will sometimes drink fuel. Fuels can cause bloat and vomiting, depression, confusion, pneumonia and death, depending on the amount ingested. There is no effective treatment.

Waste lubricants. Waste lubricants include used motor oil, transmission fluid and power steering fluids. Like fuels, these products are petroleum distillates. They also may contain

heavy metals such as lead, arsenic, cadmium or chromium, which can be toxic or leave residues in meat. All lubricants should be washed from exposed skin as soon as possible. Cattle will consume these products and therefore should not have access to them.

Ethylene glycol (antifreeze). Antifreeze is extremely toxic to the kidneys of livestock, pets, wildlife and people. It is sweet tasting, so certain animals, particularly cattle and pets, will drink large quantities if given the opportunity. Shortly after ingestion, animals appear drunk. They may vomit, become weak, convulse and die. If treated early, they may survive, but generally ethylene glycol poisoning is fatal.

8.3.2.2 Financial/liability risks

Lending and insurance agencies are concerned about the environmental risks associated with fuel storage or spillage, as well as the storage of lubricants and glycol, both new and used. They may require environmental assessments before approving loans or insurance policies. Spills of fuels or lubricants may come under the jurisdiction of the *Environmental Protection and Enhancement Act* (EPEA), and if deemed serious enough, appropriate cleanup measures will have to be taken.

Storing and Handling Fuel on the Farm, published jointly by United Farmers of Alberta and Alberta Agriculture, Food and Rural Development, provides more complete details on storage tank options, and the risks associated with fire, leakage, spillage and evaporation. It can be obtained from Alberta Agriculture, Food and Rural Development, Publications Branch, 7000 – 113 Street, Edmonton, Alberta, T6H 5T6.

8.4 Leaks and Spills

The best and lowest-cost method of dealing with a potential environmental problem is prevention.

To prevent environmental contamination:

- Always maintain separation distances from buildings, ignition sources and propane tanks.

- Store combustible materials away from fuel storage tanks.
- Keep vegetation mowed.
- Monitor fuel storage tanks to catch leaks early.

8.4.1 Fuel leaks/spills

In the event that leaks and spills do occur, keep the following points in mind:

Underground tanks. In the event of a confirmed leak in an underground tank or line, contact Alberta Environmental Protection (1-800-222-6514). Personnel from Alberta Environment will outline the procedures to follow.

Above ground. In the event of an above-ground spill or leak:

- Stop the flow of fuel. Remove all sources of ignition. Be prepared to use a fire extinguisher. Remember, gas vapours flow downhill and are extremely explosive.
- Contain the spilled fuel by damming with earth or another suitable absorbent material. Protect water sources and septic systems and try to maintain separation distances from buildings, ignition sources and propane tanks.
- Work from the upwind side to avoid inhaling vapours and becoming engulfed in flames if a fire starts.

- Clean up and dispose of all fuel by shoveling the contaminated earth or absorbent material into metal or plastic containers. Be extremely cautious with sparks from contact with rocks, metal, etc. Dispose of contaminated clean up materials in accordance with Alberta Environmental Protection guidelines.
- Ensure that all ignitable vapours are dispersed before resuming normal activities.
- It is a regulatory requirement that all spills and leaks of 200 litres or more of gasoline or diesel fuel must be reported to Alberta Environmental Protection. Spills or leaks of lesser amounts must also be reported if they have, or may have, an adverse effect on the environment. An adverse effect is defined in the *Environmental Protection and Enhancement Act* (EPEA), as impairment of or damage to the environment, human health or safety, or property. Any leak or spill of any amount into a watercourse, water body or groundwater must be reported.

8.4.2 Lubricant leaks/spills

Leaks or spills from lubricant drums or containers can be contained by using a grated pan pallet beneath the containers. Floor spills can be cleaned up with sawdust, rags or other absorbent material. Numerous commercial companies have specific products for preventing or cleaning up lubricant spills on concrete. For spills on soil, excavate the soil and dispose of it in accordance with Environmental Protection guidelines.

Disposing of waste lubricants. Most bulk fuel agents will accept waste oil, oil filters and oil containers, as well as solvents, cleaning fluids and glycols. Engine oil, transmission fluid, hydraulic fluid and power steering fluid can be combined, but must not contain water, solids, solvents or glycols. Most bottle depots also accept smaller volumes of waste oil, filters and containers. Several large waste-oil companies will pick up waste oils on the feedlot, if the feedlot has about 1,000 litres of

product per visit. The feedlot may even get paid one or two cents per litre if the waste oils are not contaminated. These companies can be found in the Yellow Pages under Oil-Waste.

Disposing of glycols. Glycols (antifreeze) should not be drained onto the ground. Waste antifreeze should be collected in plastic containers and taken to the depots mentioned above. None of the above products should be accessible to livestock, children or wildlife. Containers should be well labelled and have secure, childproof lids. Most cases of poisoning occur when children or animals accidentally handle these products. Motor oils or fuels should not be used directly on the skin of cattle. While these products were once recommended in the treatment of certain diseases, their ingestion in small quantities can produce illness or residue in the meat. In addition, these products should not be used to control dust in feedlots or on roads.

8.5 Options for Disposal of Contaminated Soils

Land spreading. Using naturally occurring soil micro-organisms in conjunction with cultivation, organic matter (manure) and added nitrogen fertilizer appears to be a reasonable method of breaking down hydrocarbons. Specific details as to amounts of contaminated soils, per given area of cultivation for a given length of treatment time, are presently being studied. However, an adequate mix would appear to be 2.5 centimetres of contaminated soil spread on a field surface with approximately 45 kilograms of manure and about 0.1 kilogram of nitrogen per nine square metres and roto-tilled to a depth of 12 centimetres. Work the area (aerated) every four weeks for at least one

year to ensure adequate breakdown of fuels and possibly for two or more years for the breakdown of waste oils.

Landfill. Contaminated soil can be hauled to an approved landfill site. Contact the landfill authority to ensure that this is acceptable.

Burning. Approved mobile thermal extractors can be used; they have the proper after-burners to completely combust all of the hydrocarbons and heavy metals. Names of companies providing this service can be obtained from Alberta Environment. Open burning of contaminated soil or clean-up materials is not an approved method of disposal.

8.6 Additional Resources

- *Livestock Mortality Management (Disposal)*, March 2002. Alberta Agriculture, Food & Rural Development, Agdex 400/29-1.
- *Livestock Mortality Burial Techniques*, March 2002. Alberta Agriculture, Food & Rural Development, Agdex 400/29-2.

9.0 PREVENTING, MANAGING AND RESOLVING CONFLICT

9.1 What is Conflict?

Conflict is a struggle between two or more parties because of a real or perceived difference in needs or values. When people or groups of people are unable to reach a satisfactory understanding of their mutual issues, the result can be disagreement or conflict.

Conflict is inevitable. Most people think conflict is negative or bad, and try to avoid it. However, conflict that is properly managed can be productive and constructive.

Conflict:

- Encourages people to examine issues more carefully.
- Deepens the understanding of problems.
- Opens the door to new ideas and alternative solutions.
- Helps people foresee the consequences of proposed actions.
- Enables people to take risks and solve problems.

9.1.1 Conflict in agriculture

In recent years, the number and intensity of conflicts facing confined feeding operations (CFOs) has risen sharply. Debated issues encompass a variety of environmental, political, economic and social issues. Public concern for human health and the environment has risen, as has inquiry into the agri-food industry and its practices.

A 1998 survey of Canadian farm organizations and producers identified conflict over farm practices as one of the leading threats to the agriculture industry's future competitiveness. A study commissioned by the Canadian Farm Business Management

Council (CFBMC) flagged issues management as one of the industry's top five priorities.

In early 1999, focus groups were held across Canada to learn about producers' experiences with farm and community conflicts. The focus groups also gathered ideas on dealing with conflict situations. The purpose of the study was to develop strategies and tools to manage conflict. Representatives from municipal, regional and provincial governments were also consulted during the study. From this CFBMC study and the current Alberta situation, the following sources of farm conflict have been identified.

9.1.2 Sources of conflict

Neighbours may have the following concerns about feedlot production:

- The biggest concern is that feedlot production will disrupt their quality of life and affect their health, mainly due to nuisance odour and dust. Feedlot producers can lessen anxiety by exercising caution, consideration and common sense. While manure odour and dust may not be an issue to those living

or working on the feedlot, others may find it offensive. A commitment to sound manure management is a necessity. Once that commitment is made, it must be kept.

- Another concern is the possibility of groundwater and surface water contamination.
- Nuisance related to storage and handling of dead animals also creates conflict.

9.2 Preventing Conflict

The single most important thing feedlot producers can do to reduce the risk of conflict is to ensure communication with neighbours is open, honest and thorough. This kind of communication is essential to lessen the impact of feedlot production on neighbours and to understand what upsets neighbours.

Focus group participants also suggest that compliance with the laws governing confined feeding operations should be regarded as the bare minimum. Employing progressive feedlot management practices and doing the very best job possible will help prevent conflicts.

The following tips and strategies to help feedlot producers prevent, manage and resolve conflict are based on the Canadian Farm Business Management Council focus groups involving producers and government representatives.

A copy of the report, *Farming with Neighbours, A Guide for Canadian Farmers on Preventing and Resolving Community Conflicts over Farming Practices*, is available from the Canadian Farm Business Management Council (phone: 1-800-232-3262, fax: 1-800-270-8301 e-mail: council@cfbmc.com).

9.2.1 Be a good neighbour

Feedlot producers need to communicate with all of their neighbours to build “social capital” that can be drawn upon like a bank account when problems do arise. Being a good neighbour, having a public relations strategy for the feedlot and contributing to the community are good ways to build up social equity within the community.

Knowing and understanding neighbours is the first step in addressing concerns about a livestock operation.

Feedlot producers should consider the following:

- Get to know the neighbours and let them get to know the feedlot operation.
- Be friendly.
- Keep neat, well-maintained feedlots which are less likely to draw complaints.

- Be helpful to neighbours in need.
- Get involved in the community. Join a local service group.
- Support local businesses. Hire local youths.
- Develop a public relations program for the feedlot. Support and make donations to local charities and community groups such as sports teams and youth groups. Get the feedlot recognized for its contributions.
- Host feedlot tours, within the constraints of the operation’s biosecurity protocol, but do a dry run to prevent unintended negative consequences.
- Help neighbours learn more about the feedlot. Explain why feedlot producers do what they do. Have an open house, picnic, barbecue or potluck.

9.2.2 Open house/feedlot tours

Several types of tours can be organized:

A public open house prior to building:

- Is a common approach for spreading information in a community.
- Can be used early in a new project development to gather ideas and test initial reaction of neighbours and the local community.
- Allows the public to learn more about the project.
- Provides neighbours with an opportunity to express their concerns.
- Ideally, are held in a neutral location.

A feedlot tour held on-site prior to start-up:

Showcase the features of the feedlot operation to the livestock industry and the community.

A tour of existing feedlots:

Follow the feedlot’s biosecurity plan during tours and incorporate the plan into the tour so that participants will learn more about generally accepted feedlot practices.

Annual summer BBQ for neighbours:

The payback from investing in annual community events is the good will that is generated and the opportunity for neighbours to ask questions in a relaxed atmosphere.

Tips for conducting a successful feedlot tour or open house:

- Find out who plans to come, why, and what they want to see.
- Decide in advance and tell guests whether photos are allowed.
- Do a dry run. Walk around the feedlot, ideally with a non-farm friend to get input on the way guests will see it. Remember, normal feedlot practices may be of concern to non-farmers.
- Ensure there are no hazards to public safety on the tour and that the feedlot is clean and tidy and livestock are healthy. Avoid waste disposal areas, sick pens, dead pits, and storage areas for medications and agricultural chemicals. Avoid direct contact with cattle.
- Anticipate the questions guests are likely to ask, including challenging issues, such as food safety, genetically modified foods, chemicals and residues, air and water, as well as soil pollution and animal welfare. Have clear, factual, well-reasoned answers ready for these questions.
- Practise answering questions with family members or colleagues. Video the practise session. Appear confident; otherwise people may think questions are being avoided or the truth is being concealed.
- If the answer to a question is not known, say so. Then offer to find an answer. Do not be baited or goaded into saying something that will be regretted later.
- Plan the feedlot tour and develop a presentation for each different visiting group. Emphasize the positive. Draw attention to the modern practices feedlot producers are using to address society's concerns, as well as the feedlot industry's contribution to the economy and community fabric.
- Tailor each presentation to the audience. Whether guests are school children, politicians, business people or other farmers, avoid using feedlot jargon.
- Talk about relevant topics; do not allow yourself to be sidetracked.
- If possible, look for opportunities to borrow professional displays on topics of interest.
- Have technical experts available to answer questions and enhance confidence in the feedlot operation's technology.
- If appropriate and in keeping with the biosecurity protocol, provide an activity that involves guest participation.
- Provide washrooms and hand disinfection facilities.
- Smile. Have fun. Guests should leave with good feelings about the tour.

9.2.3 Further advice

- Have a good attitude. Be considerate and respectful of others' concerns and opinions.
- Know the rights of feedlot producers and others. Recognize that it would be foolish to insist on acting on some rights.
- Let neighbours know in advance when manure spreading is planned. If neighbours have special events planned, try to work around them.
- When possible, avoid feedlot practices that are noisy, dusty or cause odour on or immediately before weekends, especially long weekends.
- Before planning to expand, diversify or make changes to the feedlot operation, consider the impact on neighbours and the environment. Prepare an assessment of the local situation, detailing assumptions and understandings about who the neighbours are, what they care about, potential problems and the plans for addressing any issues.
- Try to anticipate other peoples' reactions. Have answers for their concerns.
- Do not let minor disputes blow out of control.
- Fight battles privately, away from public and media view.
- Learn how to deal with and develop a relationship with the media, municipal and provincial governments.
- Search out individuals and groups that can be allies. Identify, inform and involve people who support the feedlot operation and enlist their help in dealing with opponents.
- Concentrate on keeping supporters happy. Do not spend the majority of available resources dealing with opponents.

9.3 Managing Conflict

9.3.1 Damage control

Sometimes conflict is unavoidable, no matter how much effort has been made to resolve an issue. When conflict does erupt, manage it to minimize the damage. Canadian farmers had the following tips to help prevent a conflict from escalating:

- Take the matter seriously.
- Do not try to deny there's a problem and hope it will go away.
- Stay calm. Avoid getting angry or defensive. Refrain from blaming, accusing, chiding or belittling other people; it could escalate the conflict.
- Think before acting or speaking. Sleep on it. Be diplomatic.
- Prevent small, specific conflicts from mushrooming into big, broad conflicts.
- Ask lots of questions. Find out what the other person is upset about. Don't debate their issues.
- Search out and identify the real issues. What people say may be quite different from what they're really concerned about. Often people's concerns are rooted in fear of change or the unknown or a lack of understanding, or fear of losing control or the ability to influence decisions that will affect them.
- Deal with emotions first. Then deal with the subject of the conflict.
- Listen to and validate concerns. Acknowledge understanding of the concerns and offer to look into the matter.

- Be prompt when getting back to complainants with the information they need to ease their concerns.
- Stay on top of ongoing problems. Keep people informed of changes on the feedlot and progress being made.
- Do whatever is practical to fix problems and mitigate damage.
- Always tell the truth.
- Admit to mistakes. Take responsibility for employees' actions.
- Apologize. Make amends if possible.
- When others make mistakes, help them save face.
- Shift the emphasis to mutually acceptable solutions.

Consequences for failing to problem solve may include:

- Bad publicity.
- Lost credibility.
- Fines and penalties.
- Litigation – lawsuits and appeals.
- Referendums, petitions.
- Endless meetings, more studies.
- Project delays, escalated costs.
- Loss of goodwill.
- More regulations for the whole industry.
- Increased probability of future conflicts.
- Increased difficulty to resolve future conflicts.

9.4 Resolving Conflict

The most common reason for discussion breakdown and disagreement is poor communication. Communication is a fundamental element of resolving issues and therefore must be understood and practised well. Producers should listen and understand first, and then explain their intentions. Listening also means understanding the

meaning of the other person's message from their perspective as communicated by their words and behaviour.

In today's society, conflict prevention management and resolution skills are essential. Learning the skills necessary to prevent, manage and resolve conflict will boost farmers' personal and collective competitiveness and prosperity.

9.5 References

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9.0

10.0 ALBERTA'S LIVESTOCK INDUSTRY AND GREENHOUSE GAS EMISSIONS

10.1 Why are Greenhouse Gas Emissions Important?

Greenhouse gases (GHG) trap heat in the Earth's atmosphere, which keeps the planet warm enough to support life. However, modern industry and lifestyles have rapidly increased GHG concentrations in the Earth's atmosphere. The majority of scientists studying this issue believe these increasing concentrations are contributing to global warming. Rapid global warming could result in increased severe weather and environmental events such as tornadoes, droughts, winter storms, forest fires and damage to water resources.

Canada's GHG emissions have continued to grow since 1990, making the target more distant. In Canada, all industries will be expected to do their fair share in reducing GHG emissions.

Recent surveys show that the GHG issue is also a concern to consumers. The majority of consumers in Canada and abroad feel that action on emissions must be taken.

The feedlot industry has an immediate economic stake in reducing its emissions because these emissions represent a loss of costly feed energy and nutrient inputs.

10.1.1 Livestock industry emissions

Alberta's livestock industry contributes about one percent of Canada's total GHG emissions. The main gases emitted by the feedlot industry are methane from cattle and methane and nitrous oxide from manure handling and storage. Carbon dioxide is the main GHG emitted by most other industries.

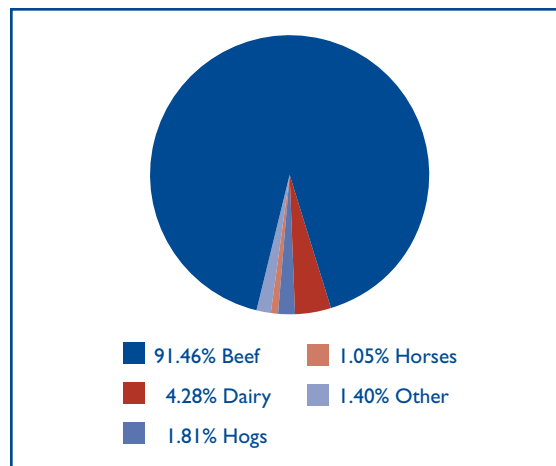
Compared to carbon dioxide, methane and nitrous oxide are very potent in terms of their greenhouse warming effect. Methane is 21 times more potent and nitrous oxide is 310 times more potent than carbon dioxide. To make comparisons clearer, measurements of GHGs are often expressed as carbon dioxide equivalents.

Figure 10.1 shows the relative proportions of GHG emissions from animals and their manures by livestock type in Alberta for 1996. (Diversified species include bison, elk, deer, goat, alpaca, llama, emu, ostrich, rhea and wild boar.)


Figure 10.1

Greenhouse Gas Emissions from Alberta Livestock

(For 1996, in carbon dioxide equivalents)



Source: Alberta Agriculture, Food and Rural Development, 1999.



All animals produce methane when they digest feed. Cattle and other ruminants, however, generate relatively large amounts of methane due to the slow fermentation of fibrous feed in the animal's forestomach, or rumen. In 1996, beef cattle accounted for 91 percent of the GHG emissions from Alberta's livestock sector.

Manure emits methane when it decomposes under poorly aerated conditions; for example, when it is solid and stockpiled with inadequate aeration inside the pile, or when it is stored as a liquid in a lagoon with little aeration. Nitrous oxide emissions from manure depend on the storage method, application method and rate, manure type and soil conditions.

Annual GHG emissions from Alberta's livestock population are projected to reach 8.26 megatonnes of carbon dioxide equivalents by 2008 to 2012, an increase of 38.4 percent from 1990 levels. This projected increase is due to expected increases in feeder cattle, dairy cattle, hogs, poultry, bison, elk and deer numbers. Therefore, if the Alberta livestock industry's practices remain the same, the industry will have to reduce its 2010 emissions by 40 percent to reach the target of six percent below 1990 levels.

10.1.2 Reducing emissions from animals

Increasing the productivity per animal reduces emissions because fewer animals are needed to achieve the same output. Many Alberta cattle feeders are already improving production efficiencies through good management practices, such as improved feed efficiencies and manure management.

The most promising avenues for reducing methane emissions from feedlot cattle are to:

Use higher quality feeds and balanced rations for mineral, protein and vitamins. This creates a hostile environment for the micro-organisms that produce methane in the rumen. Options include using high grain diets, using ensiled rather than dried forages, chopping feed, minimizing use of fibrous grasses and hays, as well as feeding concentrated supplements.

Feed ionophores and consider ionophore rotation. Ionophores are common feed additives that reduce methane formation by

rumen bacteria. Over the long term, a rotation of different ionophores may be necessary to prevent rumen bacteria from adapting to new ionophores.

Feed plant-derived edible oils. Adding edible oils like canola oil to cattle feed not only adds energy to the diet, but can also inhibit methane production in the rumen. However, this approach may not always be economical.

Add bacterial supplements to feed.

Research is underway to test the effects of adding a bacterial supplement to feed. *Brevibacillus parabrevis* is a bacterium that converts methane in the rumen to carbon dioxide. It may also improve digestion.

With further research and development, these combined strategies could come close to reducing GHG emissions from Alberta's livestock industry to the 1990 level by 2008 to 2012.

10.1.3 Reducing emissions from manure

To reduce methane emissions from manure:

- Apply manure more often, rather than stockpiling it for long periods.
- Aerate manure during composting.

To reduce nitrous oxide emissions:

- Avoid excessive manure application.
- Optimize the timing of nitrogen application.

These practices make the most of the available nitrogen and reduce the risk of crop nutrients being carried by runoff to nearby water bodies.

10.1.4 Reducing emissions from hay and pasture land

Hay and pasture land generally have relatively low GHG emissions because perennial crops are more effective than annual crops at storing carbon in the soil, thereby reducing carbon dioxide emissions.

For pasture, the key is to avoid overgrazing. Well-managed hay and pasture land also prevent soil erosion and protect water quality.

10.1.5 Summary

Governments and consumers are expecting all industries, including the feedlot industry, to reduce GHG emissions. Some practical, cost-effective options are already available for feedlot operators to reduce emissions from cattle and their manure, as well as grazing and hay lands. With widespread adoption of these

practices, the industry could significantly reduce its emissions. Some promising methods could be developed through research. Reducing emissions can improve the industry's production efficiencies, conserve soil and water resources, and inhibit global warming.

10.2 References

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Other bulletins in this series are available by calling 780-422-4385 and on Alberta Agriculture's Web site at www.agric.gov.ab.ca/.

10.3 Appendix: Greenhouse Gases – What Producers Need to Know

What determines the level of greenhouse gases?

Although most greenhouse gases (GHGs) occur naturally, modern industry and lifestyles have increased greenhouse gas emissions. Human activities have raised GHG levels by introducing new sources of emissions and by

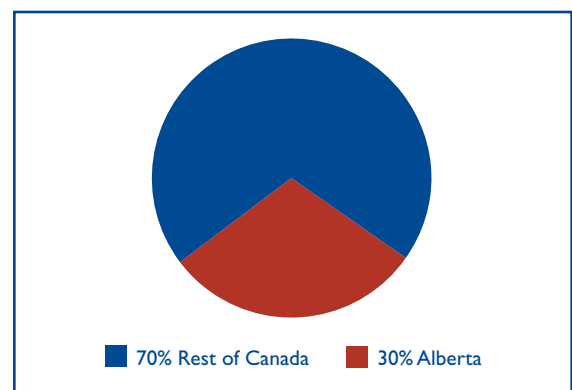
interfering with natural sinks. A balance between sources and sinks determines the levels of greenhouse gases in the atmosphere. Sources are processes or activities that release greenhouse gases; sinks are processes, activities or mechanisms that remove greenhouse gases from the atmosphere.

What are the greenhouse gas emissions from Canadian industry sectors?

In Canada, the GHGs emitted by the various industry sectors are estimated annually. Environment Canada, based on methods developed by Agriculture and Agri-Food Canada (AAFC), has determined the agriculture sector is responsible for 10 percent of total emissions of greenhouse gases in Canada (Figure 10.1). The Canadian agri-food sector, which represents about eight to 10 percent of Canadian manufacturing activity, contributes 0.5 percent of the total Canadian GHG emissions. When farm fuel consumption is taken into account, the emissions from the agriculture and agri-food industry increase to 12 percent of total emissions in Canada. The burning of fossil fuels accounts for 80 to 85 percent of human-made carbon dioxide emissions. Of Canada's total agricultural and agri-food industry's GHG emissions, Alberta accounts for 30 percent (Figure 10.2).

Figure 10.2

Greenhouse Gas Emissions from the Agriculture and Agri-Food Industry in Alberta



How does Alberta's agriculture and agri-food industry compare to other Alberta industries?

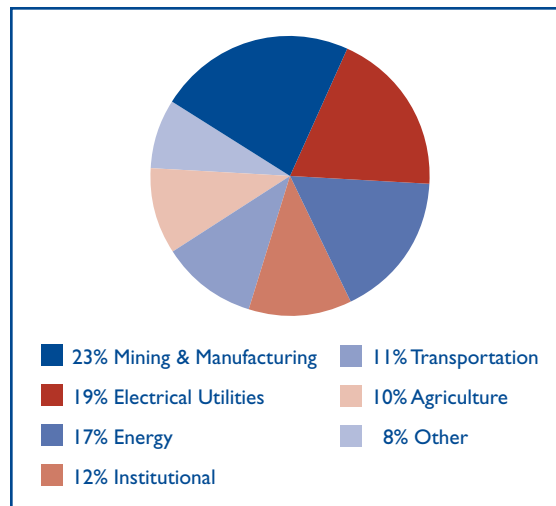
Comparing the various industry sectors across Alberta, the majority of GHG emissions stem from carbon dioxide emissions in the utilities, transportation and energy sectors (Figure 10.3).

The agriculture sector in Alberta accounts for 10 percent of the total GHG emissions, less than half of either the energy or electric utilities sectors. The agriculture sector's main emissions are nitrous oxide and methane. The agri-food sector's main emission is carbon dioxide.

Alberta Environmentally Sustainable Agriculture Council appointed by the Minister of Agriculture, Food and Rural Development, mandated to identify and evaluate environmental challenges and opportunities facing the agriculture and food processing industry and to encourage the industry to proactively address environmental issues.

Figure 10.3

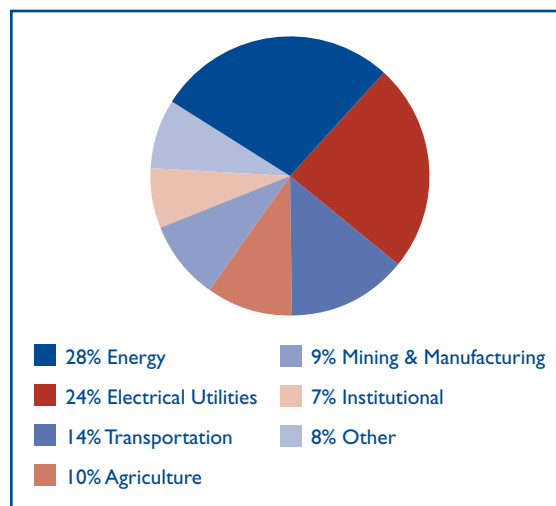
Canada's Greenhouse Gas Emissions by Sector – 1996



Source: AAFC. AESA Greenhouse Gases Workshop Proceedings, 1999.

Figure 10.4

Alberta's Greenhouse Gas Emissions by Sector – 1996



What makes the agriculture sector's emissions so different?

Nitrous oxide, methane and carbon dioxide are the main greenhouse gases emitted by the agriculture and agri-food industry. Although carbon dioxide is the main greenhouse gas emitted by other industries, the agriculture sector emits primarily methane from livestock

and nitrous oxide from fertilizer. Because emissions from agriculture are different, strategies that work in other industries, such as reducing fuel consumption and using more efficient light bulbs, will not be the entire solution for agriculture. The industry will need creative solutions to reduce GHGs that specifically address its unique situation.

What are the opportunities for the agriculture sector?

Agriculture is in a unique position because of its ability to “capture” atmospheric carbon in growing crops and store a portion of that carbon in soil organic matter. This process is known as carbon sequestration or carbon storage. Agricultural soils can be a source (emitting CO₂) or a sink (storing CO₂) for carbon dioxide, depending on the management of that soil. The Prairies account for 80 percent of Canada’s 68 million hectares of farmland. Therefore, agriculture can make a significant

contribution to meeting Canada’s GHG reduction targets. Conservation farming practices, including direct seeding and good fertilizer placement, have increased soil carbon, helping offset GHG emissions, and reducing the industry’s net emissions. Reducing GHG emissions simply means that crops and livestock can be produced more efficiently, cutting back on wasteful losses of inputs such as nitrogen (nitrous oxide) and energy (methane). Adoption of conservation practices will help to reduce GHG emissions.

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