Reference Guide
The Canada – British Columbia Environmental Farm Plan Program

Growing Forward, a federal-provincial-territorial initiative
REFERENCE GUIDE

For Use with the Publication:

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During the development of this guide, input was solicited or received from the following groups and organizations.

**Producer Groups**

- Abbotsford Soil Conservation Association
- Associated Ginseng Growers of BC
- Association of BC Grape Growers
- BC Agriculture Council
- BC Asparagus Growers Association
- BC Association of Cattle Feeders
- BC Blueberry Council
- BC Broiler Hatching Egg Producers Association
- BC Cattleman’s Association
- BC Chicken Growers Association
- BC Christmas Tree Council
- BC Cranberry Growers Association
- BC Egg Producer’s Association
- BC Emu Association
- BC Fallow Deer Association
- BC Forage Council
- BC Fox Breeders Association
- BC Fruit Growers’ Association
- BC Goat Breeders Association
- BC Grain Producers Association
- BC Greenhouse Growers’ Association
- BC Honey Producers Association
- BC Interior Bison Association
- BC Landscape & Nursery Association
- BC Llama and Alpaca Association
- BC Milk Producers Association
- BC Mink Producers Association
- BC Mushroom Marketing Commission
- BC Peace Sheep Breeders Association
- BC Pork Producers Association
- BC Potato & Vegetable Growers Association
- BC Sheep Federation
- BC Turkey Association
- BC Vegetable Marketing Commission
- BC Wine Institute
- Cariboo Sheep Breeders’ Association
- Certified Organic Growers Associations of BC
- Comox Valley Farmers Institute
- F.A.R.M. (Food and Agriculture Responsibility Members') Community Council
- Fraser Valley Bush Bean Growers’ Association
- Fraser Valley Cole Crop Growers Association
- Fraser Valley Corn Growers Association
- Fraser Valley Pea Growers Association
- Fraser Valley Strawberry Growers Association
- Horse Council of BC
- Independent Grape Growers Association of BC
- Inter-Island Sheep Breeders Association
- Island Farmers Alliance
- Kiwifruit Association of BC
- Lower Mainland Sheep Producers Association
- Mainland Dairymen’s Association
- Nanaimo-Cedar Farmers Institute
- Okanagan Kootenay Cherry Growers Association
- Peace Country Bison Association
- Peace Country Reindeer Association
- Peace River Forage Association
- Peace River Soil Conservation Association
- Raspberry Industry Development Council
- Sustainable Poultry Farming Group
- United Flower Growers’ Co-op
- Western Canada Turfgrass Association
- Western Greenhouse Growers’ Co-op Association

**Government Agencies**

- Agriculture and Agri-Food Canada
- BC Ministry of Agriculture
- BC Ministry of Forests
- BC Ministry of Health Protection
- BC Ministry of Sustainable Resource Management
- BC Ministry of Water, Land and Air Protection
- Canada Wildlife Service [CWS]
- Canadian Food Inspection Agency
- Environment Canada
- Fisheries and Oceans Canada [DFO]
- Land and Water BC Inc
- Prairie Farm Rehabilitation Administration [PFRA]
- Provincial Agricultural Land Commission

**Non Government Agencies**

- British Columbia Institute of Agrologists
- Ducks Unlimited Canada
- BC Farm and Ranch Safety and Health Agency (FARSHA)
- Malaspina University College
- UBC Faculty of Agricultural Sciences
- Union of BC Municipalities
- University College of the Fraser Valley – Agricultural Department
This Reference Guide is intended to assist producers in developing an environmental action plan for their farm. This is a plan that enhances our use of natural resources and reduces the possibility of accidental harm to soil, air, water and biodiversity values. It is one of a number of publications prepared to support the implementation of the BC Environmental Farm Plan (EFP) Program and includes a convenient summary of current legislation and regulations as well as beneficial management practices. Also included are references to other published material that might be useful in implementing an Environmental Farm Plan.

Completing an EFP will provide farmers and ranchers with an understanding of agriculturally related environmental regulations and of farm management practices that enhance environmental values. In many cases the outcome of improved water and nutrient management will also be profitable. Protecting riparian areas can improve water quality as well as enhance fish and wildlife habitat. Your decision to complete the EFP Program will bring positive recognition to yourself and your industry.

The BC Agricultural Research & Development Corporation (ARDCorp), in cooperation with federal and provincial governments, encourages all farmers to take the opportunity provided by the BC EFP Program to develop a plan that addresses environmental concerns on their farms as well as raises awareness of environmental issues pertinent to the industry. Doing so demonstrates the continuing commitment of our industry to responsible stewardship of the natural resources that are essential to a sustainable and economically viable agriculture industry for many generations to come.

On behalf of the Board of Directors,

Dick Klein Geltink
Chair
BC Agricultural Research & Development Corporation
November 2010
Limitation of Liability and User’s Responsibility

The primary purpose of the Environmental Farm Plan is to assist producers in assessing environmental risk on their farms.

While every effort has been made to ensure the accuracy and completeness of these materials, these materials should not be considered the final word on areas of practice that they cover. You should seek the advice of appropriate professionals and experts as the facts of your situation may differ from those set out in the materials.

All information in this guide and related materials is provided entirely “as is” and no representations, warranties or conditions, either expressed or implied, are made in connection with your use of, or reliance upon, this information. This information is provided to you, as the user, entirely at your risk.

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INTRODUCTION

The long term wellbeing of farms and ranches depends on good quality soil, water, air and other natural resources. In order to preserve these resources good management needs to include protection of the environment. An effective way to accomplish this broad goal is through sound environmental farm planning.

The measures necessary to sustain natural resources over the long term will depend on types of livestock raised, crops grown, farm or ranch locations within the province and on production practices. Practices described in this publication may not be suitable for all producers due to differences in weather, soil and other conditions. Additional measures may be necessary for operations where specified practices described in this publication do not protect the environment adequately. It is in the best interest of producers to determine the necessary environmental precautions for their specific situation.

This Reference Guide provides information on various environmental laws and makes suggestions for environmentally sound practices. It is the primary reference when completing worksheets in the British Columbia Environmental Farm Plan: Planning Workbook. This audit and planning process is not a legal requirement; it is a voluntary one to help producers identify areas where environmental improvements should occur on a farm or ranch.

This Reference Guide is intended for all agricultural producers in British Columbia. Suggested planning and management practices were developed with the cooperation of the BC Agricultural Council, BC Agriculture and Research Development Corporation, producer associations, and government and non-government agencies. Note that this publication and the companion Planning Workbook are designed for use on privately owned farmland. However, the discussions and principles apply to all land used for agricultural production.

USE OF THIS PUBLICATION

Publication Format

Chapters 2, 3, 4, 5 and 6. These chapters cover general information on all areas of environmental management related to farm production (Farmstead, Livestock, Crops, Pest Management, and Soil Amendments).

Chapters 7, 8, 9, and 10. These chapters cover general information on all areas of environmental management related to resource protection (Biodiversity, Soil, Water, and Air).
Chapters 11 and 12. These chapters cover broad environmental concepts within the context of agricultural production (Stewardship Areas and Climate Change).

Each of chapters 2 to 12 has the following format:
♦ a chapter "tab sheet" lists metric to imperial conversions of all measurements used in the chapter (except Table & Worksheet numbers), and has the chapter contents list on the reverse side
♦ an “Introduction” that lists all subsections
♦ the first section in farm production chapters 2, 3, 4, 5 and 6 that outlines interaction with the environment are highlighted by a green colour bar (e.g., in Chapter 4, in the Crops and the Environment section, the relationship and importance of crops in the nutrient cycle is discussed)
♦ the first section in Resource Protection and Environmental Concept chapters 7, 8, 9, 10, 11 and 12 provides the factors associated with potential Environmental impacts (e.g., in Chapter 9, the Water Quality and Quantity Factors sections deals with specific farm practices: for each practice the primary concerns, legislation and beneficial management practices are covered

Environmental Concerns – this section highlights the primary environmental concerns associated with the specific practice

Legislation – this section has a brief outline of the main legislation pertaining to the practice; this section must not be considered to be complete; an outline of other legislation that may also apply is in Appendix A

Beneficial Management Practices – this section recommends beneficial management practices that address the environmental concerns that are listed in the above section

Appendix A. Lists primary legislation affecting agriculture and the environment. Due to the importance of the Agricultural Waste Control Regulation and Code of Agricultural Practice for Waste Management it is printed in its entirety in Appendix A. Section 5.

Appendix B. Provides climatic and irrigation information.

Appendix C. Lists all publications and Internet web site addresses referred to in the text.

Appendix D. Lists glossary of terms used, as well as closely related terms.

Appendix E. Features a detailed metric to imperial conversion table.

Index. Contains an alphabetical list of subject matter with page numbers.

Conventions and Definitions
Commonly used acronyms and styles in this publication are:
♦ AGRI for the BC Ministry of Agriculture
♦ MOE for the BC Ministry of Environment
♦ Italics – identifies a piece of legislation
Equations. These are shown on a pale yellow background within the Worksheets.

Worksheets. These are laid out using a format of “question, calculation, answer,” on a light brown background. Worksheets are filled out as examples – blank Worksheets are available in the Planning Workbook.

Tables. These are shown on a light green background. If the information is used in a Worksheet, it is indicated in the right-hand end of the title bar.

Crops. Includes all agricultural crops.

Livestock. Includes all farmed animals and birds.

Legislation. References to legislation in this publication are current at the time of writing. However, legislation and the procedures to obtain permits and approvals will be changing over the next several years. If in doubt about the currency and validity of given legislation, contact the appropriate environmental agency.

Distance measurements given in legislation are meant to be horizontal, unless stated as “depth”.

Legislation is identified by either a Canadian or British Columbian flag:

![Provincial Legislation](image) Provincial Legislation ![Federal Legislation](image) Federal Legislation

Metric Measurements. This publication uses metric units except in the Water Supply and Irrigation sections where units of water are in US gallons and area is in acres.

Metric measurements are written in abbreviated form. For instance, 30 m means 30 metres, 1 km means 1 kilometre, etc. Conversions for all metric numbers used in each chapter are given on the chapter "tab page" (except Tables & Worksheets).
Environmental Farm Plans

This publication is to be used by producers as a reference when completing the Environmental Farm Plan: Planning Workbook. However, it also directs a producer to specialized Management Publications, where appropriate. These management publications are available for subjects such as Grazing, Integrated Pests (IPM), Nutrients, Riparian Areas, Irrigation, Biodiversity and Drainage. These are referred to by means of a note, such as shown below for the Nutrient Management Reference Guide.

Nutrient Management Reference Guide is a publication that forms part of the Environmental Farm Plan series on Beneficial Management Practices. Its purpose is to optimize nutrient use and to reduce environmental impacts. The Nutrient Balance Assessment, outlined on pages 6-10 to 6-16, will indicate which producers should refer to this publication for further evaluation. It will also be of interest to producers wanting to maximize the value of both manure and inorganic fertilizers. Table 6.8, page 6-16, outlines the basic steps in nutrient management planning.

Beneficial Management Practices (BMP’s)

A beneficial management practice is a farm practice which, from experience, provides environmental protection when used to carry out a particular farm activity. This publication identifies the majority of recommended beneficial management practices for the farm activities discussed. For some practices, information is referred to in separate publications.

All beneficial management practices may not need to be implemented on every farm. Some farms may be following practices, which upon review, may be found to be equal to or better than a suggested beneficial management practices.

Producers not following a prescribed practice in this Reference Guide should evaluate whether implementation of the practice will benefit the environment. Beneficial practices or their equivalents that address significant environmental concerns should be followed. Practices not addressing significant environmental concerns may still be beneficial to both the producer and the environment and may be implemented at the producer’s discretion.

Limitations of this Reference Guide

All portions of this publication will not typically apply to each producer.

It is not recommended to extract portions of this publication without considering the environmental context of the entire operation.

Individuals unfamiliar with agricultural production or resource protection should not attempt to assess a farm operation based on this publication alone. This publication is not a Regulation and is not intended to be adopted into legislation. However, government agencies are encouraged to use its contents when dealing with environmental issues affecting the agricultural industry.

This publication provides advice only and does not constitute or imply approval under any federal or provincial Acts. Contact must be made with the appropriate agency whenever approvals, permits, licences and documentation are required to implement improvements.
### CHAPTER 2  METRIC CONVERSIONS

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Conversions in this table are rounded to a convenient number.
See Appendix E for exact conversion factor.

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INTRODUCTION

This chapter discusses farmstead management for protection of the environment. It contains introductory information on the relationship between the farmstead and the environment. It also contains information on environmental concerns, legislation and beneficial management practices related to:

♦ buildings and roads
♦ farm waste
♦ chemical fertilizer
♦ petroleum
♦ woodwaste
♦ compost
♦ energy use
♦ heat production and agricultural boilers
♦ on-farm processing and sales

FARMSTEAD AND THE ENVIRONMENT

The primary role of the farmstead is to be the headquarters for farm production. Most farm construction, handling of wastes from septic and disposal sites, petroleum and woodwaste storage, composting, and processing and sales occur in this centralized location.

Many BC agricultural production sites are located in areas that are under intense pressure from non-agricultural activities. Concerns arising from farmsteads often relate to farm buildings and roads. Location, orientation and management of structures can significantly influence environmental impacts. Good site planning and management may also prevent disputes between neighbours.
The following discussion on buildings is meant to be general. Specific siting and management practices relating to fertilizers, petroleum, woodwaste, livestock, crops and pesticides buildings are found in their respective sections.

**Buildings and Roads Environmental Concerns**

Environmental concerns related to buildings and roads are:
- siting and construction that results in water pollution; or in unacceptable odours to neighbours
- escape of contents from buildings that results in air or water pollution
- impermeable surfaces such as building roofs, roads and yards that result in change of the flow, volumes and direction of runoff causing erosion or downstream flooding
- disruption of riparian vegetation, streams, lakes or wetlands due to stream crossings and bridges that result in impacts to aquatic life, wildlife and water quality

For information on these concerns:
- see Impacts on Biodiversity and Habitat, page 7-8, and refer to Farm Activities and Impacts
- see Water Quality and Quantity Factors, page 9-4, refer to Contaminants, and to Overland Flow
- see Air Quality Factors, page 10-1, refer to Contaminants, Dust and Particulates, and Odours

**Buildings and Roads Legislation**

The following is a brief outline of the main legislation that applies to buildings and roads.
- see page A-1 for a summary of these and other Acts and Regulations

**Local Bylaws**

The National Farm Building Code 1995 outlines standards for building construction and is enforced only where proclaimed by local governments.

**Agricultural Land Commission Act**

This Act requires approval from the Agricultural Land Commission to utilize non-agricultural wastes on land within the Agricultural Land Reserve.

**Drinking Water Protection Act**

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).
Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system.

- **Environmental Management Act**
  Under the *Hazardous Waste Regulation* waste oil cannot be applied to land for the purpose of dust suppression.

- **Farm Practices Protection (Right to Farm) Act**
  This Act protects farmers from liability in lawsuits alleging nuisance associated with dust, odour, noise and other disturbances resulting from the farm operation when they meet certain regulatory conditions.

- **Fish Protection Act**
  The *Fish Protection Act* enables the protection of fish and fish habitats.
  Under the Act and through the *Riparian Areas Regulation* the province can provide directives to local government to protect riparian fish habitat during their approval/allowance of residential, commercial, and industrial development. This includes residential buildings on land zoned for agricultural purposes.

- **Public Health Act**
  This Act has conditions under the Public Health Act Transitional Regulation and Sewerage System Regulation:

  *Public Health Act Transitional Regulation* Section 18: requires separation distances from wells to be at least:
  - 7 m from any dwelling house
  - 30.5 m from any probable source of contamination (probable source of contamination could include septic fields, storage buildings containing potential harmful products such as drugs or paints and solvents)
  - 122 m from any dumping ground

  The *Sewerage System Regulation* requires separations distances (as defined in the *Sewerage System Standard Practice Manual*) from wells to be at least:
  - 15 m from a holding tank
  - 30 m from a sewerage system

- **Water Act**
  This Act has a section to protect streams:
  - Section 9: requires “changes in and about a stream” to be done in accordance with an approval, licence, or order of the Act, or Part 7 of the Regulations of the Act (e.g., excavations, diversions, dams, ditches, bridges and culverts)

  The *Water Regulation*, Part 7, regulates “changes in and about a stream”
  - Section 40: requires that notification be given to MOE for certain “changes”
  - Section 44: lists “changes” authorized (not requiring an approval or licence)
Wildlife Act  The provincial *Wildlife Act* protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

- Section 6: regulates species at risk
- Section 7: makes it an offence to alter, destroy or damage wildlife habitat within a wildlife management area
- Section 34: makes it an offence to possess, take injure, molest or destroy the nest of an eagle, peregrine falcon, osprey, heron or burrowing owl or the nest of any bird not mentioned above when the nest is occupied by the bird or its egg

Fisheries Act  This Act has sections of importance to buildings and roads:

- Section 20: provides for safe passage of fish around obstructions (e.g., properly-sized culverts)
- Section 35: prohibits harmful alteration, disruption or destruction of fish habitat unless authorized (e.g., stream crossings)
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include cleanup water from concrete construction or eroded soil from construction)
- Section 37: requires approval for any work that may impact fish
- Section 38(4): requires reporting infractions of Sections 35 or 36

Species at Risk Act  This Act has sections that protect listed species, their residence and critical habitat. It applies to federal lands, internal waters (i.e., all watercourses), territorial sea of Canada, and the air space above them.

The provisions of the *Species at Risk Act* (known as the ‘safety net’) could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

BUILDINGS AND ROADS BENEFICIAL MANAGEMENT PRACTICES

Comply with applicable buildings and roads related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

Many of the following practices can be used on existing buildings and roads and all practices should be considered with new construction. Good site planning and management of structures can significantly reduce environmental impacts and may also prevent neighbour disputes.

Farm Building Siting  **Existing Building Sites.** Evaluate farm activities to ensure that pollution is not occurring, and to verify that Normal Farm Practices are being followed. The *Farm Practices Protection Act* defines a normal farm practice as an activity “that is conducted by a farm business in a manner consistent with proper and accepted customs and standards as established and followed by similar farm businesses under similar circumstances.”

When assessing an existing site, the following factors should be considered:
potential for leachate generation and/or runoff from farm building sites
→ see Runoff, page 9-42
proximity to sensitive areas (i.e. watercourses, habitat, domestic water sources, areas used for human activities)

New Building Sites. When selecting a new construction site, implement the following practices:
- for protection by the Farm Practices Protection (Right to Farm) Act
  - locate on land zoned for agriculture or in the Agricultural Land Reserve
  - follow Normal Farm Practices
- locate buildings with probable sources of contamination at least 30.5 m from a well (Public Health Act), 30 m or more from a water intake used for domestic purposes (suggested)
- locate buildings using setback “standards” from watercourses as outlined in the following publications and in the categories listed below
  - table 2.1, on page 2-7, summarizes the setback distances for each category of building
- in cases where watercourse classification mapping is not available, or in unique situations where setback standards create undue hardship or non-conformance is apparent, consult a qualified environmental professional
  - Agricultural Building Setbacks from Watercourses in Farming Areas
  - Guide for Bylaw Development in Farming Areas
  - Flood Construction Levels and Setbacks for Farm Building Situations

Category 1 facilities are structures, buildings, constructed surfaces, or areas identified by the Agricultural Waste Control Regulation which are considered to pose a high risk for causing pollution. Category 1 facilities include solid agricultural waste field storages with greater than two weeks storage, confined livestock areas with greater than ten agricultural units, and seasonal feeding areas.
- category 1 facilities must be set back 30 m from any watercourse

Category 2 facilities are structures, buildings, constructed surfaces, or areas covered by the Agricultural Waste Control Regulation and other regulations which are considered to pose a slightly lower risk for causing pollution than those in Category 1. Category 2 facilities include agricultural waste storage facilities (e.g., engineered manure pits); chemical, compost and wood waste storages; on-farm growing media production facilities; mushroom barns; confined livestock areas with less than ten agricultural units; silos; incinerators; and petroleum storages.
- category 2 facilities must be set back a minimum distance of 15 m from any watercourse

Category 3 facilities are structures, buildings, constructed surfaces, or areas which are at a higher risk of discharging contaminants than Category 4 buildings, are not identified by the Agricultural Waste Control Regulation. Examples of Category 3 facilities are livestock barns, brooder houses, fur farming sheds, livestock shelters and stables, hatcheries, and milking facilities.

Natural streams – watercourses that have not been significantly altered by human activity and are predominantly in their natural state

Channelized streams – permanent or relocated streams that have been dyked, diverted or straightened and carry drainage flows from headwaters or significant sources of groundwater. Reaches of channelized streams may be confined by roads and fences and in many cases can also meander through fields.

Man made channels that divert irrigation water from a stream but return overflow water back to a stream in a manner that allows fish access are classified as channelized streams.
**Constructed ditches** – man made drainage channels that carry drainage water from one property but do not carry water from headwaters or significant sources of groundwater. Flows in agricultural constructed ditches may be year round and are not regulated. Constructed ditches may also deliver water for irrigation purposes.

**Constructed channels** – man made drainage channels that carry drainage water from more than one property but do not carry water from headwaters or significant sources of groundwater. Flows in agricultural constructed channels may be year round and are not regulated. Constructed channels may also deliver water for irrigation purposes.

- category 3 facilities must be set back 15 m from natural and channelized streams and 5 m from constructed channels and constructed ditches, other than those maintained by municipalities, for which a 7 m setback is required.

**Category 4** facilities are structures, buildings, constructed surfaces, or areas for which a risk of discharging contaminants is not likely or can be easily contained. Examples of Category 4 facilities include greenhouses, machine storages, on-farm processing facilities, direct farm marketing facilities, crop storages, granaries, shelters, hives, machine and equipment storages, cideries, retention and detention ponds, and other impervious surfaces.

- category 4 facilities must be setback 15 m from natural streams. From channelized streams, a minimum setback of 10 m and a maximum of 15 m, is required based on two times the channel width measured from the top of bank. A 5 m setback must be left adjacent to constructed channels and constructed ditches other than those maintained by municipalities, for which a 7 m setback is required.

Take into account building setback standards as defined above, and implement the following practices when constructing a new building:

- locate on a sufficiently large land base to meet setback distances of facilities from property boundaries and consider providing room for expansion
- provide sufficient separation distance from
  - neighbours for dispersion of odour, dust and noise
  - watercourses to prevent wastes or leachate from entering
- favour sites that provide protection from wind by using windbreaks or by taking advantage of terrain
  - where protection is inadequate, favour sites where improvements can be made by planting windbreaks or constructing screens (these will also reduce noise, odour, and visual impacts an operation may have on adjacent property or occupants) → see Buffers, page 11-4
- locate structures (buildings, wind break fences, etc.) relative to one another to account for wind-drifted snow
- allow for ‘swirl chamber’ effects to deposit snow in out-of-the way locations
- make long-term plans so that future expansions do not interfere with effective waste cleanup and contaminated runoff control
- comply with local government bylaws and special management areas, if applicable
- locate on an adequately drained site, avoiding areas defined by a suggested one-in-100 year flood recurrence interval
- detain runoff from yards, buildings and roads such that peak flow to receiving watercourses is not increased over predevelopment levels
- site farm buildings such as livestock, nursery beds, greenhouses, or storages downslope from wells
- position high-activity buildings and work areas away from neighbouring residences to minimize sight and sound impacts
- avoid sensitive fish and wildlife habitat (e.g., bird nesting, riparian areas)

**Farmstead Planning** and **Siting and Management of Poultry Barns**

**Siting and Management of Dairy Barns and Operations**
### Table 2.1 Building and Facilities Setbacks from Watercourses for Riparian Protection in Farming Areas *

<table>
<thead>
<tr>
<th>Watercourse Type</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
<th>Category 4</th>
</tr>
</thead>
</table>
|                                  | • Confined Livestock Area > 10 agricultural units  
• Seasonal feeding area  
• Solid Agricultural Waste Field Storage with >2 weeks storage time | • Agricultural Waste Storage Facility  
• Chemical, compost, and woodwaste storage  
• Confined livestock area < 10 agricultural units  
• Incinerator  
• Mushroom barn  
• On-farm composting  
• On-farm soilless medium production and storage  
• Silo  
• Petroleum Storage | • Brooder house  
• Hatchery  
• Fur farming shed  
• Livestock barn  
• Livestock Shelter  
• Milking facility  
• Stable | • Boiler Room  
• Cidery  
• Cold Frame  
• Crop Storage  
• Detention Pond  
• Direct Farm Marketing  
• Granary  
• Greenhouse  
• Machinery Storage  
• On Farm Processing  
• On Farm Product Preparation  
• Retention Pond  
• Impervious Surfaces |
| Natural Streams Setbacks         | 30 m  
| Channelized Streams Setbacks     | 30 m  
| Constructed Channels and Ditches Setbackse | 30 m  

**Notes**

* Property safety and risk management concerns may require larger setbacks in some instances and will then override the setback standards shown here.

a Setback distances are measured from the top of bank.
b Channel width is determined from the top of bank to top of bank.
c The minimum building setback distance from a constructed channel or constructed ditch which a municipality is responsible for maintaining is 7 metres.
d One agriculture unit is equal to the live weight of 455 kg (1000 lbs) of livestock, poultry or farmed game or any combination equaling this weight.
e There is no differentiation between constructed channels and constructed ditches for the purposes of building setbacks, only for drainage maintenance purposes.
f The setback from a domestic water intake for all agricultural buildings is 30 m.
Whether for livestock or storage purposes, good construction ensures both effective use and low environmental impact from farm structures. Farm building plans are available from Ministry of Agriculture. Figure 2.1, next page, shows a typical barn wall with environmentally sound construction. For siting, sanitation and waste handling, construct all agricultural buildings using the following beneficial practices:

- if using off-farm wastes for fill material, ensure that they do not pollute
- use building layouts that allow for effective and efficient cleanup
- for storage buildings containing hazardous materials, ensure that impervious surfaces and continuous sills, even under doorways, are incorporated in construction for containment
- collect and manage roof water when more than a suggested 10% of the site is roofed to avoid significant stormwater flow changes caused by impervious roofing
- in high rainfall areas, incorporate eavestroughs to divert roof drainage
- divert drainage away from buildings (requires perimeter drainage), watercourses and wells, and sources of contamination (e.g., manure, compost piles)
- install gravel splash pads at the base of walls to control roof water erosion
- if buildings have galvanized metal roofing, ensure the roof water (which could contain zinc levels toxic to fish) is directed away from watercourses
- have the roof water infiltrate the soil to allow the soil to tie up the zinc
- ensure that separate drainage systems are not cross-connected during construction
- install back-flow prevention devices on all water supply lines used for medicated livestock watering, mixing pesticides, fertilizers or potentially harmful cleaning products
- extend concrete foundation walls at least 300 mm (suggested) above grade line to discourage rodents and water from entering buildings
- keep buildings in proper repair

**Building Drains.** Buildings are often fitted with perimeter drains and downspouts to divert clean roof water away from the foundation. If a layout contains drains that collect contaminated water (e.g., manure), test that the drains are not cross connected (put a ‘MOE-approved dye’ such as a water fluorescein into the contaminated drains and check that it does not exit at a clean water outlet).

**Building Ventilation.** Ventilation systems remove dust, gases and odours from buildings. In buildings where dust and odour levels are high, hoods on sidewall exhaust fans direct discharges downward toward the ground. The use of chimney fans may also be beneficial. Install hoods, protective flaps or louvers on ventilation ports to prevent the entry of rain and snow as well as to ensure predictable exhaust rates. Vegetative filters surrounding buildings or located near discharge points may be effective in intercepting odour and dust laden exhaust.

- see Indoor Poultry and Livestock Housing, page 3-2, and refer to Vegetative Filters,
- see Buffers, page 11-4
Leachate. Some buildings will have products stored or used that could be leached to ground water.
⇒ see Leachate, page 9-48

Water Supply. Some buildings will require water to be supplied to them.
⇒ see Water Supply, page 9-6

Farm Roads  Farm roads to buildings or fields may affect the natural water flow from fields and surrounding areas thereby negatively impacting nearby watercourses. Implement the following practices to minimize the impact of roads to watercourses:
♦ locate culverts to allow for controlled drainage of runoff to reduce erosion
  • the risk of concentrated water flow causing soil erosion increases as the slope and length of a road increases
♦ construct roads to follow contours
  • the risk of soil erosion increases when roads are constructed along a slope rather than across a slope
  • except for short lengths, grades should not exceed 10 percent (suggested) i.e., 1 m fall for 10 m of road length
  • steeper grades may require water bars or frequent culvert installations
♦ transport materials such as manure and pesticides well back from watercourses in case accidental spills occur
♦ have all weather roads so emergency vehicles can access farm buildings
Construct permanent farm roads with compacted, well-drained gravel or other suitable material
- keep hard-surface areas to a minimum to reduce surface runoff
- limit woodwaste use on roads
  ➔ see Woodwaste, page 2-27
- if using off-farm wastes for road construction ensure they do not pollute (such as the use of broken concrete or ground asphalt would be acceptable)
- use dust suppression agents such as water and wetting agents, calcium chloride or lignosulfonates
- used or waste oil is not allowed to be used as a dust suppressant

Buildings and Roads Near Water

Farm buildings and roads, and the management of water can have impacts on surface water and groundwater if not managed properly.

Adjacent Watercourses. Watercourses and water used for domestic purposes are protected under various environmental laws.
- site and construct farm buildings and roads so as not to negatively impact fish and wildlife habitat, and water quality and quantity
- select areas that reduce or avoid the risk of water contamination by using sufficient setbacks, buffers, or berms
- do not allow runoff that contains manure, fertilizer, pesticide, or soil that is harmful to a fisheries resource to enter a watercourse
  ➔ see Farm Building Siting, page 2-4,
  ➔ see Buffers, page 11-4,
  ➔ see Changes In and About a Stream, page 7-16,
  ➔ and see Runoff, page 9-42

Runoff. Runoff is the overland flow of water (also known as stormwater), from rainfall, melting snow or excess irrigation. Control and collect all runoff that becomes contaminated on the farm. Runoff should also be prevented from running into potential sources of contamination (e.g., manure storages, compost piles, stored silage, feed bunkers, confined livestock areas) that could form leachate, or pick up nutrients and runoff into watercourses.

Land covered by farm structures (e.g., barns, greenhouses) or impermeable surfaces (e.g., roads, yards) reduces the capability of a site to allow precipitation to infiltrate. This results in increased water leaving the farm through drainage systems (surface channels, tiles and ditches) during peak rainfall periods. This increased peak flow has the potential to cause flooding and erosion leading to the discharge of unacceptable levels of suspended solids.
  ➔ see Runoff, page 9-42

Ground Water. Determine soil permeability and ground water levels at construction sites. Environmental problems can be avoided by selecting a site with permeability characteristics suitable for controlling leaching into ground water.
  ➔ see Leachate, page 9-48

Wells provide a pathway for contaminants to ground water either by direct entry, or by entry from outside the well along the well casing.
  ➔ see Water Supply, page 9-6
Stream Crossings

Existing stream crossings should have approval from the appropriate agencies, such as Fisheries and Oceans Canada. Whenever a stream crossing is constructed or used for vehicles or livestock, it must not negatively impact fish, fish habitat, or other wildlife. Implement the following practices:

- all stream crossings should:
  - be approved by MOE and/or authorized by Fisheries and Oceans Canada
  - see Changes In and About a Stream, page 7-16
  - not damage fish habitat nor create blockages for fish passage (e.g. clear-span bridges are more “fish-friendly” than culverts)
  - see Bridge Construction (as it relates to constructed ditches)
  - be at a right angle to stream flow and at the narrowest section possible
  - have stream culverts sized to allow for safe fish passage and to carry anticipated 100 year peak flow (suggested)
  - see Culvert Installation in Constructed Ditches

- instream or bed-level crossings should
  - be approved by MOE and/or authorized by Fisheries and Oceans Canada
  - see Changes In and About a Stream, page 7-16
  - not restrict water flow and allow unrestricted fish passage
  - prevent and control sediment discharge into the stream
  - be managed to discourage livestock loitering in or near watercourses
  - if water quality is impacted by vehicle or livestock crossing, install a hard surface (such as adding gravel or concrete to a silty stream bottom)

Land Clearing and Development

Land clearing and development has the potential to alter the quality and quantity of surface and ground water flows, quality of air, and fish and wildlife habitat. Care should be taken to plan any land clearing or development to minimize disruption of natural processes. Once disrupted, these important processes and habitats are difficult, expensive and often impossible to restore. Monitor and document impacts to help assess the need for change.

- see Chapter 7, Biodiversity,
- see Chapter 9, Water,
- see Chapter 10, Air,
- see Chapter 12, Climate Change

Adjacent Land Development

Neighbouring land uses may have a negative impact on agricultural operations. Incompatible uses may include both industrial and residential development. Select new farm production sites with such influences in mind. On existing sites, scheduling activities, such as manure spreading, to avoid times when outdoor recreational activities are occurring will minimize neighbourhood disputes. On occasions where timing conflicts cannot be avoided, open communication often helps to improve understanding and acceptance.

Odour Considerations

Odour emissions from intensive production facilities (e.g. livestock or mushroom) may have a negative impact if they are sited near populated or sensitive areas. When designing and siting production facilities it is important to consider the following when predicting the frequency and intensity of odours on surrounding areas and neighbours:

- site specific climate conditions (temperature, moisture, humidity, wind speed, wind direction, etc.)
- topography of the site
management practices (manure storage and agitation practices, dust management, and manure spreading technologies)
• the use of odour reducing tools (i.e. windbreaks, vegetative buffers, biofilters and bioscrubbers)

See Odour, page 10-13

Treated Wood Products
Treated wood is often used to prevent infestation by pests and to slow decay. Properly applied and cured water-based preservatives, such as chromated copper arsenic, do not present a significant leaching problem. Oil-based preservatives, such as creosote, leach out of wood more readily and may cause problems. Wood posts treated with registered preservatives are not considered "hazardous waste" under the *Hazardous Waste Regulation* of the *Environmental Management Act*. For treated wood disposal

see Farm Refuse Disposal, page 2-15

The pollution potential posed by treating wood or by using treated material can be minimized by implementing the following practices:
• avoid erecting posts in watercourses
• use old treated materials near watercourses – freshly treated materials are more likely to leach
• if wood is to be treated on the farm, ensure that mixing, treatment, and application sites are located far from watercourses and not susceptible to spills, leaching or runoff

Abandoned Farm Sites and Farmland
Both the building sites and associated fields on farms that are no longer maintained, taken out of production or abandoned can become an environmental concern. Implement the following practices:
• ensure adequate control measures are in place to prevent pests and weeds from multiplying and affecting neighbouring farms
• remove feed sources to avoid attracting wildlife and rodents
• clean up all products that may cause pollution
• empty manure and fuel storage facilities
• properly dispose of pesticides and fertilizers

see Pesticide and Pesticide Container Disposal, page 5-22
This section discusses wastes generated on the farm but not addressed by the Code under the Agricultural Waste Control Regulation. This includes onsite sewage wastes and refuse but not manure, crop residues or mushroom media.

**FARM WASTE ENVIRONMENTAL CONCERNS**

Primary environmental concerns related to farm wastes are:
- septic absorption field failure that results in pollution of water
- materials and leachate released from on-farm refuse disposal sites that results in air or water pollution, or in attraction of wildlife

For information on these concerns:
- see Impacts on Biodiversity and Habitat, page 7-8, refer to Farm Activities and Impacts
- see Soil Quality Factors, page 8-2, refer to Contaminants
- see Water Quality and Quantity Factors, page 9-2, refer to Contaminants, and to Solids

**FARM WASTE LEGISLATION**

The following is a brief outline of the main legislation that applies to farm wastes.

- see page A-1 for a summary of these and other Acts and Regulations

**Agricultural Land Commission Act**

This Act requires approval from the Agricultural Land Commission to utilize non-agricultural wastes on land within the Agricultural Land Reserve.

**Drinking Water Protection Act**

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).
- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system

**Environmental Management Act**

This Act regulates all wastes disposed from farm and farm house operations.
- Sections 14 and 15: allow for the authorization of waste discharges, including household and other general refuse, to a site, such as an approved landfill
Note that the Code under the Agricultural Waste Control Regulation provides for exemption from Section 6(2) and (3) of the Act only for defined agricultural wastes (manure, used mushroom medium and vegetation waste).

The Hazardous Waste Regulation, the Waste Discharge Regulation and the Open Burning Smoke Control Regulation have disposal provisions for specific wastes.

**Public Health Act**

This Act prohibits activities that may cause a health hazard:
- Section 15: a person must not willingly cause a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard

The Act also has conditions under the Public Health Act Transitional Regulation:
- Section 18: separation distance of wells to be at least 30.5 m from any probable source of contamination (probable source of contamination could be septic absorption sites)

The Sewerage System Regulation requires domestic sewage be discharged into a public sewer or an approved sewage disposal system. Only authorized persons may construct and maintain systems. The owner is responsible to have maintenance done and to keep records.
- Section 3.1 requires separations distances from wells (as outlined in the Sewerage System Standard Practice Manual) to be at least:
  - 15 m from a holding tank
  - 30 m from a sewerage system

**Fisheries Act**

This Act has two sections of importance to farm waste management:
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include septic waste)
- Section 37: requires approval for any work that may impact fish
- Section 38(4): requires reporting infractions of Section 36

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**FARM WASTE BENEFICIAL MANAGEMENT PRACTICES**

Comply with applicable farm waste related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

**Farm Sewerage Systems Siting and Construction.** Construction of domestic sewerage systems from farm residences, barns and other structures are regulated by the Ministry of Health Services including septic tanks, adsorption fields and residential lagoon systems. All new and existing systems must function so as not to create a health hazard. Registered Onsite Wastewater Practitioners must be consulted if repairs or new construction are anticipated.

Separation from wells must be at least:
- 15 m from a holding tank (*Public Health Act*)
- 30 m from a sewerage system (*Public Health Act*)
Maintenance. Efficient operation of the disposal system depends primarily on maintenance of the septic tank. Periodically remove solids that accumulate in the tank to prevent them from reaching the field and causing system failure. Owners are required to maintain sewerage systems (including solids removal from the tank) according to maintenance plans as determined by a qualified professional.

Septic System Maintenance Pure & Simple
Sewerage System Standard Practice Manual

Outhouses. Outhouses or pit toilets can cause an environmental or health hazard if improperly constructed or sited. Check with the local health authority to determine what standards or guidelines for outhouses exist in the region.

Farm Refuse Disposal

Implement the following practices for approved on-farm disposal sites:
- **do not** locate the site
- on sandy or gravelly soils or in gullies
- in areas of high ground water or on a flood plain
- **do** locate the site
- at least 122 m from any well (*Public Health Act*) and down slope of any well
- 30 m or more (suggested) from any watercourse
- **do** manage the site to
- protect watercourses and ground water
- avoid wildlife attraction and wind dispersal (bury and cover wastes)
- separate livestock mortalities (use a different site)
- **do** record locations, amount, and type of material in on-farm disposal sites

Material Disposal. When purchasing, consider products that contribute to a lower impact on the environment during production, packaging, marketing and shipping. Also consider products that can be reused or recycled.

When disposing of farm waste, use permitted landfills or where they are available, waste disposal services. Untreated wood products may be reused or burnt; paint can be returned to a Product Care Depot.

http://www.productcare.org/

Plastics Disposal. Plastic wastes are not exempted by the *Code* under the *Agricultural Waste Control Regulation*, and disposal practices must therefore comply with the *Environmental Management Act*. Wherever possible, reuse or return all waste plastics to depots for recycling. The Recycling Council of BC has a hotline to answer questions about recycling in BC 1-800-667-4321. Properly dispose of plastics that have contained or contacted toxic materials.

- see Pesticide Container Disposal, page 5-22

Implement the following practices for waste plastics:
- **do** reuse plastics where possible
- reuse plant pots and bedding containers (thoroughly clean and disinfect to avoid plant disease transfer)
- replace non-recyclable or difficult to remove plastic products such as plant clips and twine with biodegradable materials
- use refillable containers
• clean and reuse waste sheet plastic for other purposes, such as coverings

♦ recycle plastics where possible
• grind up waste polystyrene for use as a potting soil amendment
• separate plastic products from plant debris and clean before recycling or taking to an approved landfill
• use a roller or baler to compress waste plastics into smaller volumes for easier handling
• encourage suppliers to accept the return of waste plastics

♦ if recycling or reusing plastics is not an option
• the preferred method is to burn products in a high-temperature incinerator, such as a municipal incinerator – do not burn on-farm due to the release of hazardous gases
  ➔ see Open Burning, page 10-17
• an alternative disposal method is to use an approved landfill – do not bury plastics on farm property

Treated Wood Disposal. Implement the following practices for disposal of treated wood material, such as pallets, boards, or posts (note that waste wood products treated with registered wood preservatives are not "hazardous waste" under the Hazardous Waste Regulation of the Environmental Management Act):

♦ reuse treated wood products for other applications such as landscape construction
♦ dispose of treated wood products at an approved landfill
♦ obtain an authorization permit from MOE to bury the material on farm property

DO NOT burn treated wood materials on the farm. High-temperature burning at an approved incineration facility is the only environmentally safe way to burn such materials. To reduce the use of treated wood products, investigate alternatives such as metal, concrete, or recycled plastic posts.
  ➔ see Treated Wood Products, page 2-12

Machinery and Equipment Disposal. When possible reuse or recycle machinery components; otherwise dispose of such products to recyclers. If spent machinery remains on the property, remove potential damaging fluids (e.g., refrigerants, oils, fuels, antifreeze) and safely dispose. Send batteries, tires and oils to collection depots for recycling.

Metal Disposal. Most suppliers of commercial products stored in metal drums and cans accept the return of these containers. Recycling options also currently exist for most types of metal containers. An alternative disposal method is to use an approved landfill – do not bury metal on farm property.

Rockwool Disposal. Rockwool is an inert, non-polluting, non-degradable soilless medium manufactured from lava rock for use in greenhouse and nursery production. Implement the following beneficial management practices:

♦ reuse rockwool where possible
♦ rotate crops to reduce or eliminate the risk of pathogens – rockwool slabs can function effectively for three to four years without replacement if handled carefully and if sterilized between crops
♦ recycle rockwool where possible
do not store product for long periods or in anticipation of recycling

where rockwool is disposed of use an approved landfill — **do not bury**

rockwool on farm property

in some cases, rockwool may be used as a soil amendment to improve soil structure and to allow any residual nutrients to be taken up by crops

- consult MOE if use of rockwool as a soil amendment is being considered

**Ash Disposal.** Ash from auxiliary fuel fired refuse incinerators that serve industrial, recreational or camp operations in remote areas can be land filled or used as a soil conditioner on farms or ranches.

- contact MOE to see if this type of ash disposal or use is appropriate

**Animal Health Care Products Disposal**

The use of medication in livestock production is common practice. Dispose of spent medicines, empty containers and other medical items in an acceptable manner. Implement the following practices:

- consult your veterinarian about the proper and safe disposal of spent medicines

- package medical waste equipment that has the potential to puncture within a rigid container, and discard with household waste if permitted

- follow suppliers’ or manufacturers’ instructions for disposal of syringes, medications, outdated medical supplies and other items

- contact MOE when disposal quantities are in excess of 5 kg or 5 litres
CHEMICAL FERTILIZER ENVIRONMENTAL CONCERNS

Primary environmental concerns related to chemical fertilizer are:
- fertilizer receiving, storing and dispensing where
  - spills or fires result in soil, water or air pollution
  - gas emissions result in air pollution
  - leachates result in water pollution
  - see Chapter 6, Soil Amendments, for information on fertilizer use

For information on these concerns:
- see Impacts on Biodiversity and Habitat, page 7-8, refer to Farm Activities and Impacts
- see Soil Quality Factors, page 8-2, refer to Contaminants
- see Water Quality and Quantity Factors, page 9-2, refer to Contaminants
- see Air Quality Factors, page 10-1, refer to Contaminants

CHEMICAL FERTILIZER LEGISLATION

The following is a brief outline of the main legislation that applies to chemical fertilizers.
- see page A-1 for a summary of these and other Acts and Regulations

**Drinking Water Protection Act**
This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).
- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system.

**Environmental Management Act**
The Spill Reporting Regulation requires spills of a polluting substance be reported immediately to the Provincial Emergency Program (PEP) at 1-800-663-3456 (24 hour service). Report spills of fertilizer greater than 50 kg or 50 litres.

**Public Health Act**
This Act prohibits activities that may cause a health hazard:
- Section 11: requires the reporting of any health hazard to a prescribed person (a health hazard may be the escape of petroleum products)
  - a prescribed person may be described by Regulations under the Act
Section 15: a person must not willingly cause a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard.

The Act also has conditions under the Public Health Act Transitional Regulation:

- Section 18: separation distance of wells to be at least 30.5 m from any probable source of contamination (probable source of contamination could include fertilizers)

**Fisheries Act**

This Act has two sections of importance to fertilizer handling and storage:

- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include fertilizers)
- Section 38(4): requires reporting infractions of Section 36

### CHEMICAL FERTILIZER BENEFICIAL MANAGEMENT PRACTICES

Comply with applicable chemical fertilizer related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

- see Chapter 6, Soil Amendments, for information on fertilizer use

#### Chemical Fertilizer Handling, Storage and Disposal

When handling, storing and disposing of chemical fertilizers implement the following practices:

- locate away from yard drain inlets, ditches, wells and watercourses
  - at least 30.5 m from wells (*Public Health Act*)
  - to meet the Agriculture Building Setback Standards (suggested)
  - see Farm Building Siting, page 2-4
  - 30 m or more from a water intake used for domestic purposes (suggested)
- locate handling and storage areas above the 100-year flood level (suggested)
- clean up fertilizer spills as soon as possible

Dry fertilizer is very soluble and should be stored under cover to prevent any water contact. Liquid fertilizers should be stored in watertight containers with secondary containment. Check storage tanks for both liquid and gaseous fertilizers every day for leaks. Liquid and gaseous storage tanks should be protected from collision.

In the event of anhydrous ammonia leak, the tank and surrounding area should be showered with water. This water should be prevented from entering a watercourse as it will contain ammonia.

Store chemical fertilizers, pesticides and fuel in separate facilities to avoid cross-contamination and unpredictable chemical reactions. Keep oxidizing fertilizers (e.g., ammonium nitrate) away from any fuel or source of open flame or spark. Buy only the amounts you need to avoid storing large amounts of fertilizer. If you must store fertilizers for longer periods of time, size facilities appropriately. Construct a storage facility such that it can be locked and have an impermeable floor with leachate and spill collection. Clearly label all containers.
Implement the following practices for unwanted, unused, old, wrongly formulated, or spoiled fertilizer:
- do not bury unwanted or spilled fertilizers on your property
- spread unused product on alternative sites or crops in amounts that ensure efficient nutrient utilization
- add small amounts to materials that are to be composted

**Chemical Fertilizer Spills**
Fertilizer spills larger than 50 kg or 50 litres must be reported in accordance with the *Spill Reporting Regulation*. If a fertilizer spill occurs implement the following practices:
- use berms or containment to prevent spread
- clean up sites by removing both fertilizer and soil that contains excess nutrients and manage the same as liquid or solid fertilizer

**Reporting Requirement**
*Under the Spill Reporting Regulation, fertilizer spills larger than 50 kg or 50 litres must be reported immediately to the Provincial Emergency Program (PEP) at 1-800-663-3456 (24 hr service).*

**Chemical Fertilizer Contingency Plan**
Develop a contingency plan when storing any amount of fertilizer. The plan should provide a timely and effective response to emergencies involving the unexpected release of fertilizer products into the environment, from:
- accidental spills, such as when transporting, storing, dispensing or applying
- release due to building fires or natural events, such as forest fires, floods, or earthquakes
- release due to vandalism
- application errors, such as applying too much fertilizer

*Contingency Plan – Template for On-Farm Planning*
PETROLEUM ENVIRONMENTAL CONCERNS

Primary environmental concerns related to petroleum are:

♦ receiving, storing, dispensing and using petroleum products where spills or fires result in soil, water, air or habitat pollution
♦ gas emissions from storage that result in air pollution
♦ disposal of used oils that results in soil, water, air or habitat pollution
♦ internal combustion engine-driven pumps that result in water pollution

For information on these concerns:

➤ see Impacts on Biodiversity and Habitat, page 7-8, refer to Farm Activities and Impacts
➤ see Soil Quality Factors, page 8-2, refer to Contaminants, and to Micronutrients and Metals
➤ see Water Quality and Quantity Factors, page 9-2, refer to Contaminants, and to Micronutrients and Metals
➤ see Air Quality Factors, page 10-1, refer to Contaminants

PETROLEUM LEGISLATION

The following is a brief outline of the main legislation that applies to petroleum products.

➤ see page A-1 for a summary of these and other Acts and Regulations

Local Bylaws

The National Farm Building Code 1995 outlines standards for above ground fuel tanks storing more than 100 litres and is enforced only where proclaimed by local government.

♦ Section 3.1.4: requires equipment being fuelled and the above ground fuel storage tanks be at least 12 m from any other building or property line. Fuel storages must be located outdoors or in buildings used only for the purpose of fuel storage.

Drinking Water Protection Act

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).

♦ Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system.
The *Spill Reporting Regulation* requires spills of a polluting substance be reported immediately to the Provincial Emergency Program (PEP) at 1-800-663-3456 (24 hour service). Report spills of petroleum or lubricants greater 100 litres.

Under the *Hazardous Waste Regulation* waste oil cannot be applied to land for the purpose of dust suppression.

**Public Health Act**
This Act prohibits activities that may cause a health hazard:
- Section 11: requires the reporting of any health hazard to a prescribed person (a health hazard may be the escape of toxic substances)
  - a prescribed person may be described by Regulations under the Act
- Section 15: a person must not willingly cause a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard

**Environmental Management Act**
This Act also has conditions under the Public Health Act Transitional Regulation:
- Section 18: separation distance from wells to be at least 30.5 m from any probable source of contamination (probable source of contamination could include petroleum products)

**Fisheries Act**
This Act has two sections of importance to petroleum management:
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include petroleum products)
- Section 38(4): requires reporting infractions of Section 36

**Migratory Birds Convention Act**
This Act prohibits the deposit of oil or waste oil onto any area frequented by migratory birds.

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**PETROLEUM BENEFICIAL MANAGEMENT PRACTICES**

Comply with applicable petroleum related legislation, including the above and where appropriate, implement the following beneficial management practices to protect the environment.

**Petroleum Storage**

**Mobile Fuel Storage.** Jerry cans, drums and truck-box fuel tanks are commonly used in farm operations. Implement the following practices:
- do not fill beyond their safe filling level
- keep drums upright and secure during transport
- avoid dispensing from horizontal drums
- have secondary containment for truck box fuel tanks that are removed from the truck or trailer and operated in a fixed location for any length of time
- carry a fuel spill cleanup kit

**Stationary Fuel Storage.** Implement the following practices for all tanks (refer to Figure 2.2, next page, for aboveground tank illustration):
- locate tanks away from yard drain inlets, ditches, wells and watercourses
  - at least 30.5 m from wells (*Public Health Act*)
- to meet the Agriculture Building Setback Standards (suggested)
  ➔ see Farm Building Siting, page 2-4
- 30 m or more from a water intake used for domestic purposes (suggested)

- support tanks on non-combustible material (e.g., metal)
- construct storage tanks in accordance with accepted engineering practices
- size spill containment to hold a single tank’s volume plus 10%, or, for multiple tanks, the largest tank’s volume plus 10%
- use an anti-siphoning device in tank discharge lines or self-closing nozzles
- ensure no drips, leaks or overflow occurs when receiving or dispensing fuel
- use bumper guards to protect tanks from direct collision by vehicles
- ensure that a fuel spill cleanup kit is readily available

MOE recommends that underground fuel storage tanks have:
- secondary containment for all tanks and piping (i.e., double-wall)
- corrosion protection for all steel tanks and piping
- a leak detection system
- an overfill protection device for the tank
- a self-closing nozzle on the dispensing line

Figure 2.2 A Well-Planned Above Ground Fuel Storage Facility

**VOC Emission Reduction from Fuel Evaporation**

Fuel evaporation during storage results in volatile organic compound (VOC) emissions and is an environmental concern. Evaporation from aboveground tanks is due to heating of the tank by the sun which causes the fuel to volatilize and vent to the atmosphere. Underground tanks have lower evaporation losses. Implement the following beneficial management practices to reduce the release of VOCs into the atmosphere:

- construct an improved fuel storage facility
- dispose of used or unwanted petroleum in a timely manner
minimize fuel evaporation from fuel storage, refer to Table 10.2, next page:

- paint fuel storage a light colour (e.g. white or silver)
- build fuel storage tanks below ground
- when possible shade tanks or build a covered storage facility

contain gases by using a pressure release valve vent cap that allows tank pressure to build up slightly before emissions are released

to estimate fuel losses from fuel storage refer to Farm Storage and Handling of Petroleum Products


see Petroleum Storage, page 2-22

Used Oil Disposal
When installing or retrofitting fuel storage facilities follow the fuel loss beneficial management practices that are outlined in Table 2.2. Improper disposal of spent or used oils can cause an environmental concern. The best alternative is to return oil to an approved recycling centre. Under the Environmental Management Act, all vendors of petroleum products are required to accept the return of waste oil from customers. Safely recover and store waste petroleum products and return them periodically to the supplier or a depot for recycling. Do not apply used oil to roads for dust suppression (Hazardous Waste Regulation).

see Farm Roads, page 2-9
## Table 2.2 FUEL LOSS BENEFICIAL MANAGEMENT PRACTICES

<table>
<thead>
<tr>
<th>Practice</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Paint the Tank.</td>
<td>The use of reflective paint (white or silver) will reduce losses by up to 40% over a dark tank. A coat of paint will also reduce rusting of the tank.</td>
</tr>
<tr>
<td>2. Use a Pressure Vent Cap.</td>
<td>Direct venting of the tank fumes are restricted until a slight pressure has built up in the tank. Losses are reduced further by 50%. A painted and pressure-vented tank has 75% less evaporation losses than a dark tank. These two improvements should be considered standard for all farm fuel tanks, especially gasoline storage tanks.</td>
</tr>
<tr>
<td>3. Shade the Tank.</td>
<td>A painted and pressure-vented tank in the shade further reduces losses by over 40%. A simple roof over the tank will provide complete shading. The cover will also reduce weathering of hoses and valves, provide storage for lubricants and solvents and provide cover from the weather while refuelling.</td>
</tr>
<tr>
<td>4. Use a Double-walled Tank.</td>
<td>While more expensive than other tanks, when replacing a tank, consider a double-walled tank for spill containment and reduced evaporation losses.</td>
</tr>
</tbody>
</table>

### Petroleum Spills

Be prepared to handle spills by having a petroleum spill cleanup kit when transporting, storing or dispensing fuels. Such a kit includes containers for contaminated waste and absorbent materials such as clay, kitty litter or sawdust and a means, such as shovel, to collect contaminated material.

Report any petroleum spill to the nearest Medical Health Officer located at the nearest Regional Health Unit, as required by the *Public Health Act*. 
Under the Spill Reporting Regulation, petroleum spills over 100 litres must be reported immediately to the Provincial Emergency Program (PEP) at 1-800-663-3456 (24hr service).

Petroleum spills of less than 100 litres do not require reporting but do need to be managed to minimize environmental impacts. If a petroleum spill can be contained and there is no danger of the spilled product leaching into a watercourse, the contaminated soil may remain in place or be moved to a safer area and spread. Soil microbes will break down the petroleum product and decontaminate the soil over time (i.e., bioremediation).

If a spill takes place in a public area such as a highway, call the local police and contact the 24-hour Provincial Emergency Program at 1-800-663-3456.

Stationary Engines. Internal combustion engines located near watercourses create a potential for contamination. To minimize this possibility, use secondary containment for the engine and its fuel tank, such as a metal pan large enough to capture fuel spills from the fuel system.

Note: small quantities of petroleum products can cause extensive water pollution.

Petroleum Contingency Plan

Develop a contingency plan when storing quantities of petroleum products. The plan should provide a timely and effective response to emergencies involving the release of petroleum products into the environment, from

- accidental spills, such as when transporting, storing, applying or dispensing
- release due to building fires or natural events, such as forest fires, floods, or earthquakes
- release due to vandalism

[Contingency Plan - Template for On-Farm Planning]
WOODWASTE

For the purpose of this publication, the definition of woodwaste is the one given in the Code under the Agricultural Waste Control Regulation:

♦ woodwaste includes hog fuel, mill ends, wood chips, bark and sawdust;
♦ it does not include demolition waste, construction waste, tree stumps, branches, logs or log ends; these are considered industrial wastes in legislation

WOODWASTE ENVIRONMENTAL CONCERNS

The environmental hazards associated with the use and storage of woodwaste are easily overlooked as wood is a natural material. The process of woodwaste decay accelerates significantly when wood is ground or chipped.

Primary environmental concerns related to woodwaste are:

♦ the handling and use of woodwaste where direct deposit into watercourses results in pollution of water or habitat loss; or application onto soil results in pollution of the soil; or storage results in pollution of air
♦ the formation of woodwaste leachate that enters watercourses or domestic water sources and results in pollution of water and fish kills

For information on these concerns:

➔ see Impacts on Biodiversity and Habitat, page 7-8, refer to Farm Activities and Impacts
➔ see Soil Quality Factors, page 8-2, refer to Carbon-to-Nitrogen Ratio, to Contaminants, and to pH
➔ see Water Quality and Quantity Factors, page 9-2, refer to Contaminants, and to Micronutrients and Metals
➔ see Air Quality Factors, page 10-1, refer to Dust and Particulates, and to Open Burning

WOODWASTE LEGISLATION

The following is a brief outline of the main legislation that applies to woodwaste.

➔ see page A-1 for a summary of these and other Acts and Regulations

Agricultural Land Commission Act

The Agricultural Land Reserve Use, Subdivision and Procedure Regulation allows the placement of soil conditioners necessary for farming on land in the Agricultural Land Reserve. Fill, necessary for farm uses of land, may be applied to land subject to some restrictions. Fill that is applied to land in the Agricultural Land Reserve that is for any purpose other than farm use requires approval.
Drinking Water Protection Act

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).

♦ Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system

Environmental Management Act

This Act has three Regulations which cover woodwaste on farms.

The Code under the Agriculture Waste Control Regulation has requirements:

♦ Section 20: woodwaste may only be used
  • as plant mulch, soil conditioner, ground cover, on-farm access ways, livestock bedding and areas where livestock, poultry or farmed game are confined or exercised
  • as berms in cranberry production
  • as fuel for wood-fired boilers

♦ Section 21: woodwaste must be stored and handled so as to prevent escape of:
  • particulate or solid matter into the air
  • particulate or solid matter or leachate into any watercourse or ground water that cause pollution

♦ Section 22: woodwaste must not be used for landfill or on sites within 30 m of any source of water used for domestic purposes

The Antisapstain Chemical Waste Control Regulation prohibits the use of woodwaste containing antisapstain chemicals from being used as mulch or as fuel in wood-burning appliances.

The Code of Practice for Soil Amendments regulates the storage, application and use of industrial residues of wood (as defined).

♦ Section 8: If more than 5m³ of soil amendments are to be applied to a site in a year, before applying the soil amendment, the discharger must have a land application plan

The Waste Discharge Regulation exempts the use of industrial wood residue as a soil conditioner or ground cover in non-agricultural operations from Sections 6(2) and 6(3) of the Act under certain conditions. The Regulation allows the use of wood residue:

♦ Section 3(5):
  • as a plant mulch or in residential gardens
  • as foundation material for animal bedding
  • as sports areas (such as riding arenas)

Public Health Act

This Act has conditions under the Public Health Transitional Regulation:

♦ Section 18: separation distance from wells to be at least 30.5 m from any probable source of contamination (probable source of contamination could include woodwaste leachate)
**Fisheries Act**

This Act has four sections of importance to woodwaste management:
- Section 35: prohibits harmful alteration, disruption or destruction of fish habitat unless authorized
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include woodwaste and woodwaste leachate)
- Section 37: requires approval for any work that may impact fish
- Section 38(4): requires reporting infractions of Sections 35 or 36

**Woodwaste Beneficial Management Practices**

Comply with applicable woodwaste related legislation, including the above, and where appropriate, use the following beneficial management practices to protect the environment.

**Woodwaste Storage**

When storing woodwaste implement the following practices:
- locate storage area away from drain inlets, ditches, wells and watercourses
  - at least 30.5 m from wells (*Public Health Act*)
  - to meet the Agriculture Building Setback Standards (suggested)
    ➔ see Farm Building Siting, page 2-4
  - 30 m or more from a water intake used for domestic purposes (suggested)
- store to prevent leachate entering surface or ground water by
  - covering piles to reduce leachate (in high precipitation areas, cover woodwaste between October 1st and April 1st)
  - using impermeable surfaces to prevent leaching into soil and groundwater
  - collect or contain leachate with berms
- use appropriate construction or adequate buffer to keep woodwaste from blowing onto watercourses and neighbours ➔ see Buffers, page 11-4

**Woodwaste Use**

Appropriate agricultural uses of woodwaste are restricted to plant mulch, animal bedding, groundcover, farm access ways and fuel for boilers. When using woodwaste, implement the following practices:
- do not place directly into surface water
- use adequate buffers between areas receiving woodwaste and watercourses to prevent leachate contamination ➔ see Buffers, page 11-4
- do not apply woodwaste to a depth of greater than 15 cm per year in outdoor areas (suggested)
- limit the total depth of woodwaste applied outdoors to no greater than 30 cm total (suggested)
- do not use woodwaste that may contain antisapstain chemicals, wood preservatives, or fire retardation chemicals
  - woodwaste containing these chemicals can affect livestock, wildlife and fish that come into contact with the treated woodwaste or leachate
- to reduce the risk of causing pollution, utilize sawdust from weathered woodwaste or from less toxic softwood tree species such as spruce, pine or fir, or from hardwoods
  - avoid using the bark of softwood trees, wherever possible, since they contain more resinous ingredients than heartwoods or sapwoods (resinous ingredients have a higher risk of producing toxic leachate)
• use weathered woodwaste with low bark content near sensitive areas (the production of leachate declines as woodwaste ages)
• apply only to soils having a carbon-nitrogen ratio (C:N) of 30:1 or lower
• do not shred woodwaste unless necessary (shredding increases surface area, resulting in more rapid decomposition, generating more toxic leachate)
• collect all leachate that poses the potential to pollute surface water or ground water → see Woodwaste Leachate Control, page 2-31
• use alternative materials where polluting woodwaste leachate cannot be collected

Livestock Bedding. Sawdust and shavings can be excellent wood-based beddings. Implement the following additional practice:
• monitor the Carbon-to-Nitrogen ratio (C:N) of soil receiving bedding (repeated applications of bedding may result in a C:N shift that could reduce crop growth in time)

Drainage Systems. Implement the following additional practice:
• do not use woodwaste as a substitute for drain rock around drainage piping

Riding Arenas and Turnout Paddocks. Implement the following additional practices:
• ensure that drainage systems under woodwaste riding arenas and turnout paddocks do not discharge into any ditch, creek, stream, or pond
• do not use woodwaste as landfill to level a site (apply clean fill for levelling purposes before laying down any woodwaste)
• use alternative footing materials, such as sand, if the woodwaste stipulations within the Code under the Agricultural Waste Control Regulation cannot be met

Crop Mulches. Implement the following additional practices:
• minimize the depth and width of mulch around plants
• limit the application of woodwaste mulches in combination with nitrogen application to prevent crop “burning” and nutrient loss as woodwaste begins to degrade
• do not irrigate with water containing woodwaste leachate if the water contacts the crop
• use other materials such as compost or clean chopped straw if runoff or drainage containing woodwaste leachate cannot be handled in an environmentally sound manner

On-Farm Access Ways. Implement the following additional practices:
• do not use woodwaste simply as a fill material
• use other products, such as geotextiles with gravel and sand on roadways, if runoff or drainage containing woodwaste leachate cannot be handled in an environmentally sound manner
Cranberry Berms. Implement the following additional practices:
♦ do not allow woodwaste on the outside face of external cranberry bog berms to be in direct contact with drainage ditch water
♦ cap the top of all berms with an impermeable soil material to reduce leaching of woodwaste
♦ where possible, use alternative materials, such as gravel and/or geotextiles

Nursery Bedding Material. Implement the following additional practice:
♦ for the preparation of nursery beds, use geotextile fabrics either alone or in combination with sand and gravel as alternatives to woodwaste

Fuel for Boilers. The Code under the Agricultural Waste Control Regulation has requirements for using wood as a fuel for boilers.
⇒ see Heat Production and Agricultural Boilers, page 2-39

Open Burning. Before burning woodwaste material, ensure that alternative end uses such as bedding, mulch material, or compost feedstock has been considered.
⇒ see Open Burning, page 10-17

Woodwaste Leachate Control

Woodwaste leachate is generated by water moving through woodwaste and is characterized by a dark colour, "oily" sheen and a foul odour. Varying amounts of leachate are produced in almost all situations where woodwaste is used. Areas of the province with higher precipitation are more prone to leachate generation. Irrigation has a similar effect. Surface runoff from woodwaste can carry toxic leachate to adjacent fish-bearing streams or to ditch water that enters fish-bearing watercourses. Prevent leachate from entering watercourses or domestic water supplies.

The impacts of woodwaste on the environment will be minimized when it is used on well-drained upland sites with medium-textured soils and a deep water table. Leachate detoxification occurs at sites by natural attenuation in the soil. Fine-textured soils have a high ability to attenuate leachate, but restricted infiltration may reduce the amount of attenuation since more runoff is likely to occur. On rapidly drained sites with coarse-textured soils, limit the amounts of woodwaste to account for the sites lower absorption and degradation capacity. On poorly drained sites where the water table is near the surface, some form of drainage system may be needed to collect and treat leachate.
⇒ see Contaminant Movement in Soil, page 8-15

Limiting Leachate. Limiting use of woodwaste to only that which is absolutely necessary reduces leachate production. Limit contact time between leaching waters and woodwaste. Reducing the thickness of applied woodwaste, covering stored woodwaste, and diversion of uncontaminated runoff to prevent infiltration are all effective means of reducing leachate production.

Leachate Collection, Treatment and Use.
⇒ see Leachate, page 9-50 for collection and treatment and use.
COMPOST ENVIRONMENTAL CONCERNS

Primary environmental concerns related to compost are:
♦ storing, handling and processing raw materials that results in soil, water or air pollution
♦ disposal of leachate that results in soil, water or air pollution
♦ odour, particulate and gas emissions from composting that results in air pollution
⇒ see Chapter 6, Soil Amendments, regarding compost application to land

For information on these concerns:
⇒ see Soil Quality Factors, page 8-2, refer to Contaminants
⇒ see Water Quality and Quantity Factors, page 9-2, refer to Contaminants, and to Oxygen Demand
⇒ see Air Quality Factors, page 10-1, refer to Contaminants, to Dust and Particulates, and to Odours

COMPOST LEGISLATION

The following is a brief outline of the main legislation that applies to composting.
⇒ see page A-1 for a summary of these and other Acts and Regulations

Local Bylaws
Many local governments enforce specific bylaws that place restrictions on composting.

Agricultural Land Commission Act
The Agricultural Land Reserve Use, Subdivision and Procedure Regulation allows the production, storage and application of compost from agricultural wastes produced on the farm for farm purposes if at least 50% of the compost measured by volume is used on the farm.

Drinking Water Protection Act
This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).
♦ Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system
This Act has three Regulations that address composting on farms.

**Environmental Management Act**

The *Code* under the *Agricultural Waste Control Regulation* specifies acceptable agricultural composting activities.

♦ **Section 3**: agricultural wastes must be collected, stored, handled, used and disposed of in a manner that prevents pollution

♦ **Section 15**: agricultural waste may only be composted on the farm
  • if the agricultural waste consists only of waste produced on the farm, or if produced elsewhere, is being composted for use on the farm
  • the composting site must be located at least 15 m from any watercourse and at least 30 m from any source of water for domestic purposes
  • must be composted in a manner that does not cause pollution

♦ **Section 16**: composting agricultural waste for the production of mushroom media on a farm is allowed
  • if the mushroom medium produced is used only on that farm
  • if the composting site is located at least 15 m from any watercourse; at least 30 m from any source of water for domestic purposes
  • if media is composted in a manner that does not cause pollution

♦ **Section 19**: states that the *Code* is not intended to prohibit various odours from agricultural operations or activities on a farm, providing such operations or activities do not pollute (Note: a Provincial Court of BC judgement found odours that cause or are capable of causing material physical discomfort to a person are considered emissions that cause pollution – odours not causing pollution may still be a nuisance to neighbours)

♦ **Section 30**: agricultural products must be managed to prevent the escape of agricultural wastes (agricultural products include farm inputs and outputs)

The *Organic Matter Recycling Regulation* has requirements related to the on-farm composting of off-farm “organic matter” wastes and the co-composting of farm waste. Red meat slaughter wastes and poultry processing wastes are included in materials regulated under the *Organic Matter Recycling Regulation*.

The *Mushroom Composting Pollution Prevention Regulation* applies to a farm that is producing mushroom media that will be sold off-farm. It regulates air and water discharges by requiring an implemented pollution prevention plan. The specifications for the plan are identified in the *Regulation*.

This Act prohibits activities that may cause a health hazard:

♦ **Section 15**: a person must not willingly cause a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard

**Public Health Act**

The Act also has conditions under the *Public Health Act Transitional Regulation*:

♦ **Section 18**: separation distance from wells to be at least 30.5 m from any probable source of contamination (probable source of contamination could include compost materials and leachate)
This Act has two sections of importance to compost management:
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include compost materials and leachate)
- Section 37: requires approval for any work that may impact fish
- Section 38(4): requires reporting infractions of Section 36

**Fisheries Act**

**COMPOST BENEFICIAL MANAGEMENT PRACTICES**

Comply with applicable composting related legislation, including the above, and where appropriate, use the following beneficial management practices to protect the environment.

- see Chapter 6, Soil Amendments, regarding compost application to land

**Compost Handling and Storage**

**Production Site.** The primary consideration when siting a compost production area is the prevention of water pollution. Some situations may require distances greater than those specified in legislation.

- see Farm Building Siting, page 2-4

Potential odour nuisance complaints or other conflicts with neighbours, such as noise impacts, may be reduced by using the following practices:
- locate buildings according to the Agriculture Building Setback Standards (suggested) see Farm Building Siting, page 2-4
- locate buildings and operations as far as possible from rural residences or residential areas
- take advantage of unique topography or microclimate conditions that could affect odour impacts
- site buildings and operations so that prevailing winds transport odours away from rural residences or residential areas
- use visual screening such as trees or natural mounds

**Materials Storage.** To avoid runoff and odour problems, store raw materials and finished compost under cover. Storage areas can be a simple, open structure with a roof. A concrete push wall could be added at one end to aid in the handling of materials with a front-end loader. Organic materials, if not handled carefully, may begin to decompose while in storage.

If the product is stored directly on the ground rather than on a raised concrete pad, divert runoff from the area. see Runoff, page 9-42

**Compost Facility.** Composting is a method of recycling organic matter into stable organic material that can serve as a nutrient source or soil conditioner. The composting process should promote aerobic decay of organic materials while preventing the escape of potentially harmful gases and liquids. An effectively managed setup will produce temperatures high enough to destroy disease organisms contained in the plant material.
Carefully design buildings used for composting to provide adequate ventilation and interior visibility. Choose building techniques and products to withstand the high levels of ammonia and humidity that develop in most composting operations. Improper design will lead to moisture condensation, frost build-up and accelerated deterioration of the structure.

Good housekeeping practices, including frequent cleanup of spilled materials, will reduce the potential for odour problems.

**BC Agricultural Composting Handbook (series of Factsheets)**

### Compost Leachate Control

During decomposition of organic materials, nitrate-nitrogen, ammonia and organic compounds are produced. If water passes through compost materials, runoff carrying these compounds will be generated, causing risks to surface water and ground water. Covering stored compost raw materials and finished compost, and diversion of uncontaminated runoff to prevent infiltration, are all effective means of reducing leachate production. ➔ see Leachate, page 9-48

In areas receiving high precipitation, composting on bare ground without cover is not recommended. Significant leaching from compost piles will occur, transporting organic and nutrient contaminants into the soil. These contaminants will slowly move down through the soil and may contribute to ground water pollution. Therefore, composting in high precipitation areas should be conducted under cover, on impervious surfaces with leachate collection.

In low rainfall areas, compost may be produced outside on uncovered concrete slabs, as shown in Figure 2.3, below. Collect, store, and recycle or apply all runoff to land. ➔ see Runoff, page 9-42

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**Figure 2.3  A Well-Planned Outdoor Composting Facility**
Composting Odour Control

The composting process inevitably results in the release of large amounts of moisture and ammonia. If ammonia and other gases are released at unacceptably high levels, it may be necessary to enclose the composting facility completely and incorporate air emissions treatment systems. Chemical scrubbers and biofilters remove offensive odours from exhaust air. Chemical scrubbers may be necessary if biofilters are overloaded with ammonia gases.

→ see Indoor Poultry and Livestock Housing, page 3-5, and refer to Biofilters

Ensuring compost piles are aerated, by regular turning or by piping air through piles (static aeration) will reduce production of inacceptable odours.

To reduce odour impacts on neighbours establish and maintain an adequate buffer between compost operations and neighbours to keep odour from causing a nuisance or pollution. → see Buffers, page 11-4

Composting Noise Control

Grinding of raw ingredients, mixing of products and turning of compost piles can all generate significant amounts of noise. To reduce noise impacts on neighbours consider the timing of the operations. Also establish and maintain an adequate buffer between compost operations and neighbours to keep noise from causing a nuisance. → see Buffers, page 11-4

Mushroom Media

Implement the general composting practices outlined above and use specific mushroom media practices. → see Mushroom, page 4-17

Composting Livestock Mortalities

Implement the general composting practices outlined above and use specific livestock mortality practices. → see Livestock Mortality Disposal, page 3-37
ENERGY USE

ENERGY USE ENVIRONMENTAL CONCERNS

Primary environmental concerns related to energy use are:
♦ excess and inefficient use of energy that results in air pollution, or results in the unnecessary generation of greenhouse gases

For information on these concerns:
⇒ see Air Quality Factors, page 10-1, refer to Dust and Particulates and to Volatile Organic Compounds
⇒ see Climate Change Factors, page 12-1, and refer to Agricultural Greenhouse Gases

ENERGY USE LEGISLATION

Carbon Tax Act

The Carbon Tax Act establishes a carbon tax in BC. Carbon tax is a broad based tax that applies to the purchase or use of fuels, such as gasoline, diesel, natural gas, heating oil, propane, coal, and the use of combustibles, such as peat and tires, when used to produce heat or energy. Carbon tax applies to fuels at different rates depending on their anticipated carbon emissions, and the tax rates are scheduled to change on July 1, 2011 and 2012. Farmers are required to pay carbon tax on fuel purchased or used for farming operations.

ENERGY USE BENEFICIAL MANAGEMENT PRACTICES

Energy Use

Where appropriate, implement the following beneficial management practices to protect the environment.

Purchase energy efficient equipment and use technologies that reduce energy consumption and gas emissions that contribute to climate change. Energy auditing services are valuable in identifying areas where such advantages can be realized.

Energy Use in Buildings and Yards. For energy efficiency in and around buildings, implement the following practices:
♦ design and construct buildings to take advantage of natural light and the solar energy of the site
♦ use high efficiency furnaces for space and water heating
♦ use energy efficient lighting such as fluorescent, sodium, and metal halides
♦ use electrically efficient motors
♦ use control systems such as temperature, humidity and light sensors, timers, and dimmers that fine-tune energy input at required times and amounts
♦ use levels of insulation, vapour barriers and weather stripping in heated and cooled buildings that take local climatic conditions into account
♦ design livestock ventilation systems using appropriate minimum winter and maximum summer ventilation rates
♦ use heat exchangers on ventilated buildings (especially in colder climates)
♦ use directed lighting in areas that require focussed tasks to be accomplished
♦ use renewable sources of energy such as wind, solar, geothermal, biomass where economical ➔ see On-Farm Energy Production, page 12-11
♦ establish shelterbelts and windbreaks around farm buildings to conserve heat and improve energy efficiency ➔ see Buffers, page 11-4
♦ in greenhouses, use curtains to minimize night time heat losses
♦ in greenhouses, capture excess daytime heat resulting from carbon dioxide generation for use during night time heating
♦ where used, have heating and ventilation systems fully interlocked

**Energy Use in Field Operations.** For field operations implement the following practices:
♦ use fuel efficient tractors, trucks, and stationary equipment
♦ use appropriate fuels for different seasons
♦ avoid extended engine idling
♦ match tractor power to expected loads by “gearing up – throttling down”
♦ maintain all powered equipment as recommended by the manufacture
♦ minimize the number of passes over a field by carrying out multiple operations at the same time
♦ use no till or reduced tillage practices
♦ use radial tires on all powered mobile equipment
♦ keep tires at recommended inflation pressures
♦ ballast tractors for optimum match of wheel slip, horsepower, and speed
♦ use efficient irrigation and watering systems to reduce pumping energy

[Link: Pumping Livestock Water – It’s all about energy choices!]
[Link: Energy Free Water Fountains]

**Energy Use in Crop Drying and Feed Processing.** For crop drying and feed processing facilities implement the following practices:
♦ use fuel efficient dryers and electrically efficient motors
♦ use automatic controls on low temperature aeration drying or monitor drying conditions frequently
♦ use continuous drying systems where possible
♦ monitor moisture content of materials while drying so that excessive drying is avoided
HEAT PRODUCTION AND AGRICULTURAL BOILERS

HEAT PRODUCTION AND AGRICULTURAL BOILER
ENVIRONMENTAL CONCERNS

Primary environmental concerns related to heat production with boilers are:
♦ release of particulate matter from biomass fired boilers, and
♦ release of particulates and other harmful air contaminants (sulphur oxides and nitrogen oxides) from the burning of fossil fuels in boilers which can result in
  • health risks from inhaling the particulate
  • visual impairments from the emissions and due to the formation of smog
  • environmental impacts
♦ emission of carbon dioxide (CO₂) from fossil fuel fired boilers which contributes to climate change
  • the combustion of biomass is considered to be carbon neutral

For information on these concerns:
⇒ see Air Quality Factors, page 10-1
⇒ see Climate Change Factors, page 12-1

HEAT PRODUCTION AND AGRICULTURAL BOILER
LEGISLATION

The following is a brief outline of the main legislation that applies to heat production and agricultural boilers.
⇒ see page A-1 for a summary of these and other Acts and Regulations

Local Bylaws
Regional and municipal governments can pass bylaws to control emissions from boilers.

Environmental Management Act
Under the Environmental Management Act, local governments may be delegated authority to manage air quality within their boundaries (e.g. Metro Vancouver). Local and regional governments can pass bylaws that regulate emissions from industrial, commercial and industrial sources, through permits, compliance promotion and enforcement.

The Code under the Agricultural Waste Control Regulation regulates emissions from biomass fuelled boilers used in agricultural production:
♦ Section 18: regulates types of acceptable fuel and emissions from biomass fired boilers used in agricultural production
Sections 18.1 – 18.6 set emission standards, testing and reporting requirements for boilers and heaters fuelled by biomass

The *Agricultural Waste Control Regulation* and the Metro Vancouver *Agricultural Boilers Emission Regulation Bylaw No. 1098* are harmonized with respect to boiler emission limits, registration, monitoring and reporting and allowable fuel types. If you are located in Metro Vancouver, please refer to the Metro Vancouver bylaw 1098.

[http://www.metrovancouver.org/boards/bylaws/Bylaws/GVRD_Bylaw_1098.pdf](http://www.metrovancouver.org/boards/bylaws/Bylaws/GVRD_Bylaw_1098.pdf)

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HEAT PRODUCTION AND AGRICULTURAL BOILER BENEFICIAL MANAGEMENT PRACTICES

Emissions Standards

Traditional fuel sources for boilers include natural gas, heating oil, propane and in a few cases, coal. Due to rising fuel costs, these fuel sources are being replaced by biomass and subsequently new regulations that set standards for air emissions from agricultural boilers have been implemented. In 2008, the amendments to the *Code* under the *Agricultural Waste Control Regulation* and Metro Vancouver’s bylaw No.1098 were introduced to establish consistent rules for all boilers used in agriculture. The *Code* as well as the *Agricultural Boilers Emission Regulation Bylaw* defines biomass used for boiler fuel as:

- agricultural fuel products, including agricultural pellets, manure pellets, corn kernels, corn stalks, seed hulls or wood or wood products
- but does not include any raw manure; paper or paper product; wood or wood product that has been treated with glue, paint or preservative, that contains a toxic substance or is salt laden

The *Code* under the *Agricultural Waste Control Regulation* sets the emission standards for biomass boilers used in agriculture. These limits are seen in Table 2.3 below. Metro Vancouver’s emission standards in the bylaw are harmonized with these standards.

### Table 2.3 Emissions regulation limits for Boilers and Heaters Fuelled by Biomass

<table>
<thead>
<tr>
<th>Capacity of Boiler or Heater</th>
<th>Emission Standards (effective September 1, 2010)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Particulate Matter Limit</td>
</tr>
<tr>
<td>Greater than 3 MW</td>
<td>35 mg/m³</td>
</tr>
<tr>
<td>Greater than 1 MW but not greater than 3 MW</td>
<td>50 mg/m³</td>
</tr>
<tr>
<td>Less than 1 MW</td>
<td>120 mg/m³</td>
</tr>
</tbody>
</table>
Any person who is operating a boiler or heater for agricultural purposes is required to register with the Ministry of Environment or, if located in the Greater Vancouver Regional District (Metro Vancouver), with Metro Vancouver before the boiler or heater is used. This can be done by following the online registration guide found at:

- if located in BC, outside of Metro Vancouver
  http://www.env.gov.bc.ca/epd/industrial/regs/ag_waste_control/index.htm#3
- if located in Metro Vancouver
  http://www.metrovancouver.org/services/permits/Pages/airquality.aspx

Table 2.4 below will help to determine the boiler output.

<table>
<thead>
<tr>
<th>Table 2.4 Boiler Capacity Conversion to Megawatts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler capacity information may be found on the boiler nameplate (metal tag attached to the boiler), or from the boiler manufacturer.</td>
</tr>
</tbody>
</table>

**Reporting Capacity in megawatts (MW)**:

- \( \frac{\text{GJ/hr}}{0.2778} = \text{MW} \)
- \( \frac{\text{MMBTU/hr}}{0.2931} = \text{MW} \)
- \( \frac{\text{Boiler BHP}}{0.009803} = \text{MW} \)

**Example:**
The boiler plate indicates energy input of 400 BHP:
Therefore 400 BHP \( \times \frac{0.009803}{1} = 3.9212 \text{ MW} \).

*GJ – Gigajoules, MMBTU – Millions of British Thermal Units, BHP – Boiler Horse Power

**Emissions Reduction**
Comply with applicable emissions related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

- use energy management systems that ensure optimization of temperature and humidity
- implement emission control devices on biomass burners
- ensure biomass fuels have optimum moisture content
- use boilers with low particulate generation
- implement a maintenance program for solid fuel boilers and all heating system components
- use appropriately sized and efficiently operated heating plants for greenhouse and other production facilities
- use cleaner burning material in burners to ensure a clean burn and maximize energy generation
- separate out and do not burn contaminated biomass, such as treated wood
- establish and maintain adequate windbreak and shelterbelt buffers around farm buildings and livestock facilities to improve energy efficiency ➔ see Buffers, page 11-4
- maximize the use of on-farm renewable energy, such as wind or solar to reduce imported energy needs ➔ see On-Farm Energy Production, page 12-11
On-farm product preparation refers to the cleaning, sorting, separating, grading, or packing of farm products.

On-farm processing refers to processes that include mixing; drying; canning; size reduction; fermentation; and heat, cold, chemical or biological treatment to prepare farm products or value-added products for sale.

→ see Crop Processing, page 4-10, for processing livestock feed

### ON-FARM PROCESSING AND SALES ENVIRONMENTAL CONCERNS

Primary environmental concerns related to on-farm processing are:
- disposal of processing wastes, waste product and wash water that results in soil, water or air pollution
- washing or processing crops with poor water quality (e.g., pathogens) that results in food unfit for consumption

For information on these concerns:
→ see Soil Quality Factors, page 8-2, refer to Contaminants, and to Salts
→ see Water Quality and Quantity Factors, page 9-2, refer to Contaminants, and to Oxygen Demand
→ see Air Quality Factors, page 10-1, refer to Dust and Particulates, to Odours, and to Open Burning

### ON-FARM PROCESSING AND SALES LEGISLATION

The following is a brief outline of the main legislation that applies to on-farm processing and sales.

→ see page A-1 for a summary of these and other Acts and Regulations

**Local Bylaws**

Local governments may regulate aspects of on-farm processing and sales that relate to size, setbacks, parking, signage, and hours of operation.

**Agricultural Land Commission Act**

The Agricultural Land Reserve Use, Subdivision and Procedure Regulation outlines permitted processing and sales activities in Section 2 and 3.

**Drinking Water Protection Act**

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).
♦ Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system

**Environmental Management Act**

On-farm processing wastes are not regulated by the *Agricultural Waste Control Regulation*, and may require authorization for introduction of a waste to the environment. The discharge of processing waste may require a permit from MOE.

The *Ozone Depleting Substances and Other Halocarbons Regulation* regulates the servicing of refrigeration equipment and disposal of refrigerant gases.

The *Code of Practice for the Slaughter and Poultry Processing Industries* regulates the disposal of solid and liquid wastes produced by the slaughter industry under the *Waste Discharge Regulation*.

This Act prohibits activities that may cause a health hazard:
♦ Section 15: a person must not willingly cause a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard

**Public Health Act**

The Act also has conditions under the Public Health Act Transitional Regulation:
♦ Section 18: separation distance from wells to be at least 30.5 m from any probable source of contamination (probable source of contamination could include processing wastes)

Under the *Food Premises Regulation*, food premises must be connected to a source of potable water and be connected to a waste disposal system, among other requirements.

**Canada Agricultural Products Act**

This Act has conditions under the *Fresh Fruit and Vegetable Regulation* requiring that no stagnant or polluted water is used in the washing or fluming of the produce, and only potable water is used in the final rinsing of the produce to remove any surface contaminant before packing.

**Fisheries Act**

This Act has three sections of importance to processing facilities:
♦ Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include processing wastes)
♦ Section 37: requires approval for any work that may impact fish
♦ Section 38(4): requires reporting infractions of Section 36
ON-FARM PROCESSING AND SALES BENEFICIAL MANAGEMENT PRACTICES

Comply with applicable on-farm processing and sales related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

On-farm product preparation, processing and sales can generate wastes and cause impacts which, for regulatory purposes, may not be regarded as agricultural. In such cases, investigate the requirements of the Environmental Management Act to ensure that environmental concerns are addressed.

Wastes derived from processing of primary agricultural production (e.g. carrot tops, stems of flowers) should be handled in the same manner as farm wastes. If the wastes can be adequately dealt with by the farming operation, a permit or approval may not be required. It is advisable to contact MOE if there are any questions regarding the handling and disposal of a particular waste material.

Separate approvals are required from both the Ministry of Health Services for domestic waste disposal and from the Canadian Food Inspection Agency to ensure food safety and quality for on-farm processing operations.

Product Processing & On-Farm Direct Sales Facilities

For all agricultural operations that process product for direct sale, implement the following practices:

♦ locate facilities away from yard drain inlets, ditches, wells and watercourses
  • at least 30.5 m from wells (Public Health Act)
  • to meet the Agriculture Building Setback Standards (suggested)
  ➔ see Farm Building Siting, page 2-4
  • at least 30 m from a water intake used for domestic purposes (suggested)
♦ design and manage a facility so that contaminated runoff from parking lots, roofs, and other hard surfaces does not enter watercourses or wells
♦ have a professional design storage lagoons and tile fields for domestic sewage and register the sewage discharge with Ministry of Environment or Ministry of Health Services (Environmental Management Act)
♦ recycle containers (e.g., berry flats), wash water, etc. whenever possible

Processing Water Quality. Agricultural operations that process product for direct sale use large volumes of water during processing operations. Implement the following practices to maintain water quality.

♦ ensure water quality for processing, such as washing, meets potable (drinking) water requirements (Canada Agricultural Products Act)
♦ never discharge wash water directly into a watercourse
♦ never discharge wash water into a domestic sewer system without approval
♦ dispose of wash water in an environmentally acceptable manner

Treating Irrigation and Crop Wash Water for Pathogens
Drinking Water Quality. Direct farm markets may provide drinking water to customers. Ensure water quality standards are met by implementing the following monitoring practices:

♦ if providing drinking water to the public, ensure water meets drinking water standards (*Drinking Water Protection Regulation*)
  • no detectable fecal coliform bacteria per 100 ml
  • no detectable Escherichia coli per 100 ml
  • no detectable total coliform bacteria per 100 ml if a single sample is taken in a 30 day period
  • at least 90% of samples have no detectable total coliform bacteria per 100 ml and no sample has more than 10 total coliform bacteria per 100 ml if more than one sample is taken in a 30 day period
♦ ensure limits on chemical and physical parameters (such as nitrates and heavy metals) are met

Guidelines for Canadian Drinking Water Quality

Abattoirs

On-farm butchering, and the wrapping, freezing and processing of meat generates environmental concerns. The Ministry of Environment has established the *Code of Practice for the Slaughter and Poultry Processing Industries* that addresses discharges to the environment from the slaughter and poultry processing industries. A number of other specific regulations and requirements that apply to abattoirs are administered primarily by the Canadian Food Inspection Agency, BC Center for Disease Control and the BC Ministry of Health Services.

Composting Processing Wastes. Some wastes from on-farm processing can be composted. Ensure that composting meets the requirements of the *Organic Matter Recycling Regulation.* ➔ see Compost Legislation, page 2-32
# CHAPTER 3 METRIC CONVERSIONS

<table>
<thead>
<tr>
<th>Metric</th>
<th>Imperial Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>600 mm</td>
<td>24 inches</td>
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<td>1 m</td>
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<td>50 feet</td>
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<tr>
<td>30 m</td>
<td>100 feet</td>
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<tr>
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<td>330 feet</td>
</tr>
<tr>
<td>2 m²</td>
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<tr>
<td>6 m²</td>
<td>65 square feet</td>
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<td>2,100 m²</td>
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</tr>
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<td>1540 pounds</td>
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<td>625 lbs/ac</td>
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<td>22 litres</td>
<td>5.8 gallons</td>
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<tr>
<td>45 litres</td>
<td>12 gallons</td>
</tr>
<tr>
<td>50 litres</td>
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</tr>
<tr>
<td>20 MPa</td>
<td>3,000 psi</td>
</tr>
</tbody>
</table>

Conversions in this table are rounded to a convenient number. See Appendix E for exact conversion factor.

Values from tables and examples are not included in Metric Conversions.
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INTRODUCTION

This chapter discusses livestock management practices for protection of the environment. It contains introductory information on the relationship between livestock and the environment. It also contains information on environmental concerns, legislation and beneficial management practices related to:

- indoor poultry and livestock housing
- outdoor livestock areas
- manure handling and storage
- mortality disposal

LIVESTOCK AND THE ENVIRONMENT

Livestock are primarily raised and managed in farm operations for their value as food or food products, or in the case of horses, for recreational or other uses. Environmental concepts related to livestock activities are listed in alphabetical order below.

**Grazing**

Livestock that graze on pasture or grass rangelands indirectly provide humans with food from forages, a food source otherwise not useable by humans.

**Nutrient Cycle**

When livestock graze or are fed grains and forage they become part of the nutrient cycle of a site. Depending on the management practices for a given site, livestock may:

- remove nutrients by consumption as in grazing (with some retained in body mass)
- add nutrients by consumption of feed transported to the site (with some deposited as wastes)

Depending on the nutrient requirements of a site, either may be positive or negative to the environment. Evaluate the nutrient status of grazing and feeding areas when deciding on fertilizer or manure application rates.

**Vegetation Control**

Livestock that graze are used to manage specific undesirable types of vegetation such as weeds and competing vegetation in forests.
Primary environmental concerns related to indoor livestock areas are:

- impacts of indoor poultry and livestock housing on water quality:
  - release of wastes (e.g., manure, milkhouse waste, bedding, spoiled feed) that results in water pollution
  - housing located close to a watercourse or well that results in water pollution
  - cross connection of “dirty water” lines with clean water lines that results in water pollution

- impacts of indoor poultry and livestock housing on air quality:
  - release of methane (CH₄) and ammonia (NH₃) from housed livestock manures that add to the greenhouse effect and smog formation
  - release of particulate matter and ammonia from animal housing as a result of manures and dust that can chemically produce secondary particulate that results in human health risks and in visibility reduction
  - release of odours associated with ammonia or other noxious gases that is carried by dust to surrounding neighbours

For information on these concerns:

- see Water Quality and Quantity Factors, page 9-1, refer to Contaminants, and to Oxygen Demand
- see Air Quality Factors, page 10-1, refer to Contaminants, to Dust and Particulates, to Greenhouse Gases, and to Odours
- see Climate Change Factors, page 12-1

The following is a brief outline of the main legislation that applies to indoor housing.

- see page A-1 for a summary of these and other Acts and Regulations

**Drinking Water Protection Act**

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).

- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to
be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system.
The Code under the Agricultural Waste Control Regulation has specific requirements regarding agricultural wastes:

- Section 3: agricultural wastes must be collected, stored, handled, used and disposed of in a manner that prevents pollution
- Section 7(1): a storage facility must be located at least 15 m from any watercourse; at least 30 m from any source of water for domestic purposes

The Code also has a single reference to air emissions from animal housing:
- Section 17: states that emissions from forced air ventilation systems must not cause pollution

This Act prohibits activities that may cause a health hazard:

- Section 15: a person must not willingly cause a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard

The Act also has conditions under the Public Health Act Transitional Regulation:
- Section 18: separation distance of wells are to be at least 30.5 m from any probable source of contamination (a probable source could include manure)

This Act has two sections of importance to indoor poultry and livestock areas:

- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substance could include manure)
- Section 38(4): requires reporting infractions of Section 36

Comply with applicable indoor housing related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

- **Protection of Water Quality**
  An indoor structure allows for convenient collection and containment of livestock manure and waste feed. However, inappropriate barn location, improper construction practices or improper management can contribute to pollution from wastes or leachate. Implement the following practices for indoor facilities:
  - locate facilities away from yard drain inlets, ditches, wells and watercourses
    - at least 30.5 m from wells (*Public Health Act*)
    - at least 15 m from watercourses (*Agricultural Waste Control Regulation*)
    - 30 m or more from a water intake used for domestic purposes (suggested)
  - locate facilities so that an adequate buffer can be established and maintained between indoor housing and watercourses
  - keep wastes or leachate from entering a watercourse
  - construct floors to contain all wastes
♦ deposit waste feed into manure storages or store separately to prevent leachate generation
♦ place berms around buildings or grade landscapes near structures to keep snow melt or other water flow from entering the indoor facility
⇒ see Buildings and Roads, page 2-9

**Milkhouse Waste.** Collect and deposit milkhouse waste into a manure storage facility for eventual land spreading as a fertilizer. Alternative disposal systems require a permit from MOE.

**Building Drains.** Buildings are often surrounded by perimeter drains to carry clean roof water and soil moisture away from the foundation. If the barn or barnyard also has drains collecting contaminated water, implement the following practice:
♦ test that these drains are not cross connected to the clean water drains
♦ add a MOE-approved dye into the contaminated water drain, and check that the dye does not show up in the clean drain line discharge

**Protection of Air Quality**

Indoor poultry and livestock housing can impact air quality by emitting dust, particulate and gaseous compounds. These emissions can be a nuisance as well as impact human and environmental health.

**Particulate Emissions Reduction.** Implement the following practices to reduce particulates and dust from livestock housing:
♦ practice dust suppression techniques and implement dust suppression technology
♦ clean up dust accumulations inside the barn
♦ use clean, low dust litter for bedding
♦ when loading bedding into barns, use methods that result in minimal dust production
♦ incorporate a program of washing down both the interior and exterior of barns to remove dust accumulations
♦ clean fans, hoods and screens regularly to avoid dust build up
♦ properly locate ventilation exhaust fans
♦ direct discharge away from other buildings and neighbours
♦ equip fans with hoods that deflect exhausted air towards the ground (the ground cover acts as a filter), or install chimney fans with discharge openings at least 4 m (suggested) above ground level (to maximize dilution)
♦ take advantage of prevailing winds to carry particulates away from sensitive areas
♦ maintain foliage or implement vegetative filters near exhaust fan discharges to trap a proportion of dust exiting the barn
⇒ see Buffers, page 11-4
⇒ Fine Particulates - What They are and How They Affect Us
⇒ Siting and Management of Poultry Barns

**Ammonia Emissions Reduction.** To reduce ammonia emissions that contribute to the formation of secondary particulate and cause odour concerns, implement the following practices:
♦ balance the diet to maximize feed efficiency to minimize excreted nitrogen
♦ use enzymes when possible to enhance feed efficiency and reduce phosphate excretion
⇒ see Manure Gas Emissions Reduction, page 3-35, and refer to Nutrition and Ration Management

**Odour Reduction.** Odours often result from livestock housing due to manure, enteric fermentation, and the release of ammonia, and dust.
⇒ see Odours, page 10-13

**Exhaust Filters.** Mechanical air filtration systems trap approximately 45% of fine particulate and 80% of coarse particulate from animal housing areas.
♦ install mechanical filters on ventilation exhaust fans
♦ ensure filters are cleaned and maintained at regular intervals

**Biofilters.** Biofilters result in approximately an 80% reduction in ammonia and 95% reduction in hydrogen sulphide emissions and can be used as an alternative to mechanical filters. Mechanical filters trap particles and emissions, whereas biofilters trap particles and emissions and also provide an environment for aerobic biological degradation of trapped compounds that results in a reduction of odour emissions.
♦ install biofilters to reduce odorous emissions
♦ biofilters are proven effective for use on deep pit manure exhaust; swine, dairy and mushroom facilities; and are minimally effective in poultry facilities
♦ Caution: dust and dander in certain types of poultry housing can cause exhaust filters and biofilters to backup
Figure 3.1 Biofilter System on an Indoor Livestock Facility

### Table 3.1 Considerations When Installing a Biofilter*

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Ventilation Requirements</th>
<th>Per Animal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hogs – Gestation</td>
<td>71</td>
<td>Per Animal</td>
</tr>
<tr>
<td>Hogs – Farrowing</td>
<td>236</td>
<td>Per Animal</td>
</tr>
<tr>
<td>Hogs – Nursery</td>
<td>17</td>
<td>Per Animal</td>
</tr>
<tr>
<td>Hogs – Finishing</td>
<td>57</td>
<td>Per Animal</td>
</tr>
<tr>
<td>Broiler/Layer (2.3 kg)</td>
<td>2</td>
<td>Per Animal</td>
</tr>
<tr>
<td>Turkey (18 kg)</td>
<td>15</td>
<td>Per Animal</td>
</tr>
<tr>
<td>Dairy (635 kg)</td>
<td>222</td>
<td>Per Animal</td>
</tr>
</tbody>
</table>

3. **Size and footprint of biofilters:**
   - The depth of the biofilter depends on the design and the amount of contact time the odorous air spends in the biofilter:
     - typically 25 to 45 cm deep
   - The footprint of the biofilter depends primarily on the amount of air needing treatment:
     - typically biofilters are 0.8 to 1.4 ft² per 1000 cubic feet per second (cfs) of airflow

*adapted from University of Minnesota, Biofilters for odour control, 2000

Table 3.1, above, outlines considerations to take into account when installing a biofilter to reduce odours and emissions from livestock housing facilities.

**Vegetative Filters.** Vegetative filters trap a portion of dust from barns exhaust fans, reduce the visual impacts of agriculture, and decrease odour. In a vegetative filter, wind is channelized from the barn exhaust through a planting of trees, allowing particulates to be caught in the vegetation.
- see Buffers, page 11-4,
- see Vegetative Buffers, page 10-14

**Electrostatic Precipitators for Dust Reduction.** Reduce dust emissions from indoor livestock facilities by applying a safe electric charge to the air space. Electrostatic precipitators reduce dust in the air by charging the airspace to force particles to come together and fall out of the air. This reduces the impacts to both indoor and outdoor air quality.
- implement electrostatic precipitators in livestock housing at beginning of the livestock cycle
- clean up dust accumulations to ensure the technology remains effective
OUTDOOR LIVESTOCK AREAS

OUTDOOR AREA ENVIRONMENTAL CONCERNS

Primary environmental concerns related to outdoor livestock areas are:
- livestock manure and feed that results in soil, water, air pollution and/or greenhouse gas emissions
- livestock grazing that results in loss of wildlife habitat and weed transmission, or results in soil compaction or erosion, or water pollution

For information on these concerns:
- see Impacts on Biodiversity and Habitat, page 7-8, and refer to Farm Activities and Impacts
- see Soil Quality Factors, page 8-2, and refer to Compaction, and to Contaminants
- see Water Quality and Quantity Factors, page 9-2, and refer to Contaminants, and to Oxygen Demand
- see Air Quality Factors, page 10-1, and refer to Contaminants, and Odours
- see Climate Change Factors, page 12-1

OUTDOOR AREA LEGISLATION

The following is a brief outline of the main legislation that applies to outdoor livestock areas.
- see page A-1 for a summary of these and other Acts and Regulations

**Drinking Water Protection Act**
This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).
- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system

**Game Farm Act**
This Act requires farms with bison, fallow deer and reindeer have a license to operate. Licenses specify containment fencing requirements among other items.

**Environmental Management Act**
The Code under the *Agricultural Waste Control Regulation* defines and regulates confined, seasonal feeding and grazing areas. Table 3.2, page 3-10 lists typical names used for various livestock areas.
Confined Livestock Area. This is an outdoor, non-grazing area in which livestock are confined by fences, structures or topography. Most or all feed is brought to the livestock and deposited manure nutrients exceed crop needs if a crop is grown at all.

- Section 10: outdoor under pen storage of manure is permitted for up to 9 months (unique to fur farms)
- Section 12: manure must be applied to land as a fertilizer or soil conditioner
- Section 28: livestock in a confined livestock area can not have access to a watercourse for watering (a conditional exception is allowed for a rangeland holding area)
- Section 29(1): areas must be operated in a way that does not cause pollution
- Section 29(2): areas are to be at least 30 m from any watercourse, high tide watermark or any source of water used for domestic purposes

Seasonal Feeding Area. This is an area used for both crop production and for seasonal feeding of livestock. Most of the feed is brought to the site and manure nutrients do not exceed crop needs.

- Section 26(1): the area must be operated in a way that does not cause pollution, and have berms where necessary to prevent agricultural waste runoff from causing pollution
- Section 26(2)(a): locations for feeding must be at least 30 m from watercourses or high tide watermark, unless written permission has been obtained for a closer location from MOE
- Section 26(2)(b): locations for feeding must ensure that manure is spread as a fertilizer or soil conditioner and that no accumulation of manure pollutes
- Section 26(3): permanent feed bunks require written permission from MOE for their location
- Section 27: livestock are allowed access to natural watercourses, provided feeding meets item 26 and the access is located and maintained as necessary to prevent pollution

Grazing Areas. This is an area where livestock are sustained primarily by direct consumption of the feed growing on that area.

- Section 25: livestock are allowed access to natural watercourses, provided they do not cause pollution

Public Health Act This Act prohibits activities that may cause a health hazard:

- Section 15: a person must not willingly cause a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard

The Act also has conditions under the Public Health Act Transitional Regulation:

- Section 18: separation distance of wells are to be at least 30.5 m from any probable source of contamination (a probable source could include manure)

Water Act Water licences are required from Front Counter BC for use of surface water. A licence is not required for livestock drinking directly from a watercourse in a...
grazing area or in a rangeland situation. Approval is required for any work in or about a stream.

**Wildlife Act**
The provincial *Wildlife Act* protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

**Fisheries Act**
This Act has three sections of importance to outdoor livestock areas:
- Section 35: prohibits harmful alteration, disruption or destruction of fish habitat (e.g., hoof action in or around streams) unless authorized
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances would include manure)
- Section 38(4): requires reporting infractions of Sections 35 or 36

**Species at Risk Act**
This Act has sections that protect listed species, their residence and critical habitat. It applies to federal lands, internal waters (i.e., all watercourses), territorial seas of Canada, and the air space above them.

The provisions of the *Species at Risk Act* (known as the ‘safety net’) could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

### OUTDOOR AREA BENEFICIAL MANAGEMENT PRACTICES

Comply with applicable outdoor area related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

Broad environmental concerns of outdoor livestock areas are expressed in this rule-of-thumb:

**Keep clean water away from manure,**
**Keep manure away from clean water.**

**Fur Farms**
Section 10 of the *Code* under the *Agricultural Waste Control Regulation* permits outdoor under-pen storage of manure for up to 9 months (unique to fur farms). For information on manure ➔ see Manure Beneficial Management Practices, page 3-23

**Game Farms**
Farming of bison, fallow deer and reindeer have unique management requirements under the *Game Farm Act.*

[British Columbia Game Farm Manual](#)

The *Code* under the *Agricultural Waste Control Regulation* defines three outdoor livestock areas. Common terms used for these areas are outlined in Table 3.2, next page.
Table 3.2  Typical Outdoor Area Terms for Livestock Groupings

<table>
<thead>
<tr>
<th>Livestock Type</th>
<th>Outdoor Area (as defined by the Code under the Agricultural Waste Control Regulation)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Confined</td>
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<tr>
<td>Beef Cattle</td>
<td>feedlot</td>
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<tr>
<td></td>
<td>handling corral</td>
</tr>
<tr>
<td></td>
<td>pen</td>
</tr>
<tr>
<td>Bison</td>
<td>feedlot</td>
</tr>
<tr>
<td></td>
<td>handling corral</td>
</tr>
<tr>
<td></td>
<td>pen</td>
</tr>
<tr>
<td>Chickens &amp; Turkeys</td>
<td>free range</td>
</tr>
<tr>
<td>Dairy Cattle</td>
<td>yard</td>
</tr>
<tr>
<td>Fallow Deer &amp; Reindeer</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Fur farms</td>
<td>—</td>
</tr>
<tr>
<td>Game Birds (e.g. pheasant)</td>
<td>free range</td>
</tr>
<tr>
<td>Goats</td>
<td>yard</td>
</tr>
<tr>
<td>Horses</td>
<td>arena</td>
</tr>
<tr>
<td></td>
<td>paddock</td>
</tr>
<tr>
<td>Laying Hens</td>
<td>free range</td>
</tr>
<tr>
<td>Llamas &amp; Alpacas</td>
<td>pen</td>
</tr>
<tr>
<td>Ostriches &amp; Emus</td>
<td>pen</td>
</tr>
<tr>
<td>Hogs</td>
<td>yard</td>
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<td>Rabbits</td>
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<td>Sheep</td>
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<tr>
<td></td>
<td>lambing pen</td>
</tr>
<tr>
<td>Water Fowl</td>
<td>free range</td>
</tr>
</tbody>
</table>

**Horse Riding Arenas**

Horse riding arenas are considered to be confined livestock areas and must be managed as such. Ideal arena footing materials should have a low potential for producing leachate, for instance sand is better than woodwaste. If woodwaste is used its leachate must be managed → see Woodwaste, page 2-27. Dry areas with good drainage will provide a more serviceable, easily maintained facility regardless of the type of footing chosen. Do not locate arenas in wet areas, that by nature pose the highest pollution potential when woodwaste, manure, or urine are in contact with water. Divert water around the arena to ditches or streams to minimize pollution.

Building an Environmentally Sound Outdoor Riding Ring

**Outdoor Calving Areas**

Cattle calving areas can be either confined livestock areas or seasonal feeding areas. Where contaminated runoff is at risk of reaching watercourses, give
special attention to runoff control. Calf manure often contains Cryptosporidium parvum, a protozoan pathogen that can cause illness in humans if ingested in drinking water.

**Confined Livestock Areas**

Commonly called pens, yards, loafing areas, or exercise areas, confined livestock areas may be used either for many months to house livestock or for short periods of time to give indoor-housed livestock fresh air and sunshine. They may be used for feeding, watering or confinement purposes.

There are a number of ways to manage confined livestock areas to reduce the likelihood of depositing deleterious substances into water frequented by fish or of causing water pollution. Implement the following practices:

- Locate facilities away from yard drain inlets, ditches, wells and watercourses
  - at least 30.5 m from wells (*Public Health Act*)
  - at least 30 m from a watercourse or high tide watermark (*Agricultural Waste Control Regulation*)
- Install a hard surface (e.g. concrete, asphalt) instead of a soil-based yard, as indicated by Worksheet #1, next page
- Install a water supply system as watercourse access is not permitted from confined livestock areas (a conditional exception is allowed for a rangeland holding area)
  ➤ see Livestock Water, page 9-13
- Establish and maintain an adequate buffer between the outdoor area and any watercourse to keep wastes, or leachate from the wastes, from entering a watercourse
  ➤ see Buffers, page 11-4
- Handle, process, and store feed properly
  ➤ see Crop Processing, and Forage Crop Storage, page 4-10
- Divert upland area “clean water” away from confined livestock areas
- Collect confined livestock area contaminated runoff (“dirty water”) or use sites where contaminated runoff is prevented from reaching watercourses
  ➤ see Runoff, page 9-42
- If contaminated runoff is collected
  - estimate the volume to be collected using Worksheet #11, page 9-47
  - use the water appropriately
  ➤ see Contaminated Water Collection, Storage and Use, page 9-44
- Prevent the escape of manure from the area and collect and spread it as a fertilizer (*Agricultural Waste Control Regulation* requirement)
Worksheet #1  Soil-Based Confined Livestock Areas  Workbook Question 89
Determining Suitability and Size

**Question:** A producer in Merritt has 100 head of feeder cattle weighing as much as 350 kg and wants to house them on a continuous basis on a soil-based yard. The soil is a low risk soil. Is a soil-based yard suitable and what is the minimum yard space required for continuous use?

**Information:**
- Precipitation on the site from Oct 1 to April 30 (select site): Merritt 280 mm
- Risk of leachate movement in soil (refer to table 8.1): Low
- Number of livestock: 100
- Average weight of livestock: 350 kg
- Minimum space for soil-based yards: 6 m² per 100 kg (continuous use), 2 m² per 100 kg (day use only)

**Calculation:**

**Step 1** Determine if a soil-based yard is suitable.

*Is Box 1 less than 600 mm, and is Box 2 low risk?*

**YES**  Continue to step 2 or 3

**Step 2** Determine the size of the soil-based yard if it is continuous use.

(A soil-based yard area of 6 m² /100 kg or greater is suitable for continuous use)

**Equation:**

Soil-Based Yard Size = Number of Livestock x Average Weight x Minimum Space

= 100 head x 350 kg x 0.06 m²/100 kg

= 2100 m²

**Step 3** Determine the size of the soil-based yard if it is day use only.

**Equation:**

Soil-Based Yard Size = Number of Livestock x Average Weight x Minimum Space

= 100 head x 350 kg x 0.02 m²/100 kg

= 700 m²

**Answer:** For this Merritt farm example, a soil-based confined livestock area is suitable, with a continuous use yard for 100 cattle averaging 350 kg requiring a minimum area of 2,100 m².
**Soil-Based vs. Hard-Surfaced Yards.** In general, extensive use for more than 72 hours continuously of soil-based, confined livestock area is best suited to sites that have all of the following:

- are located in low precipitation climates, less than 600 mm October 1<sup>st</sup> to April 30<sup>th</sup> inclusive ➔ see Appendix Figure B.1, page B-2
- and have soil with a low risk of contaminant movement ➔ see Table 8.1, page 8-16
- and have low-density livestock use, requiring the following minimum areas
  - for continuous use, an area of 6 m<sup>2</sup> or greater per 100 kg of livestock
  - for day-only use, an area of 2 m<sup>2</sup> or greater per 100 kg of livestock

Use hard surface confined livestock areas if **any one of the above conditions are not met**. Refer to Worksheet #1, previous page, for an example of determining suitability and sizing a soil-based confined livestock area.

**Confined Soil-Based Yards.** Heavy traffic and sustained use of soil-based confined livestock areas, especially in wet conditions, either destroys plant cover totally or leaves a cover that is sparse and weedy. In addition, soil compaction prevents precipitation from infiltrating the soil, causing ponding and increased runoff flow that could cause erosion.

Non-vegetated, wet and muddy confined livestock areas do not provide many of the benefits for which they are intended. High moisture conditions contribute detrimentally to the health of animals. As well, excessive amounts of manure and other waste accumulate, increasing the risk of contaminated runoff.
For soil-based yards, shown in Figure 3.2, previous page, include the general confined area beneficial management practices, and implement the following practices:

- align bedded mounds to drain runoff to collection areas, then use the water appropriately
  - see Contaminated Water Collection, Storage and Use, page 9-44
- install hard surfacing to heavy livestock traffic areas and to areas along feed bunks and adjacent to waterers

**Confined Concrete or Hard-Surfaced Yards.** For concrete or hard-surfaced yards, shown in Figure 3.3, below, include the general confined area points on page 3-11, and implement the following practices:

- minimize the yard area to reduce the amount of precipitation that mixes with manure, and to reduce the labour needed to keep the area clean
- divert roof water and clean water from surrounding areas to prevent mixing with contaminated water within the yard
- regularly clean the open yard area by scraping wastes to storage structures suitable for either semi-solid or liquid manure
Estimating Confined Livestock Area Runoff Volume. Use Worksheet #11, page 9-47, to estimate runoff volume:

- the formula uses a design storage capacity based on the most winter precipitation expected in 25 years (recommended by MOE)
- the winter storage period (either 6 or 7 months) depends on when the storage can be emptied in the spring
  - during the cropping season (May to October) any contaminated runoff can be directly applied to cropland for utilization

Seasonal Feeding Areas Seasonal feeding areas are unique for two reasons:

- they are used for crop production, seasonally they are used for feeding livestock, and
- under the Code under the Agricultural Waste Control Regulation, these are the only areas where manure can be deposited (by the livestock) on crop land during winter (i.e., where livestock are fed, manure is deposited)

Section 26 of the Code under the Agricultural Waste Control Regulation requires seasonal feeding areas are managed so that:
♦ livestock or livestock manure is spread over the crop land such that no area receives more nutrients than the crop needs
♦ runoff that leaves the area does not cause pollution

As seasonal feeding areas are used during the non-growing season, (not a preferred time to be spreading manure), the risk of runoff causing pollution is high. Runoff protection measures will be required for:
♦ high precipitation climates (precipitation is greater than 600 mm from Oct 1st to April 30th inclusive)
♦ areas where snow melting on frozen ground causes runoff

**General Considerations.** Implement the following practices:
♦ have stocking densities that do not cause soil compaction
♦ handle, store, and process feed properly
  ➔ Crop Processing, and Forage Crop Storage, page 4-10
♦ harrow manured areas in the spring to break manure clods
♦ collect and spread manure that is generated near fixed feed bunks as a fertilizer
♦ monitor watercourses for impacts from livestock watering and bedding by
  • checking visually for channel instability caused by hoof action from livestock having access to watercourses
  • lab testing for chemical and bacteriological contamination of watercourses caused by runoff or direct livestock access
♦ maintain runoff controls (e.g., ditches, berms, etc.)
♦ before using a feeding area, and where practical and appropriate, remove snow to reduce contaminated runoff
♦ limit livestock use of wet pastures to prevent soil compaction by keeping livestock in confined areas
♦ limit access to riparian areas by using fencing and off-stream watering
♦ when used as cow calving areas, give special attention to runoff flows
  ➔ see Outdoor Calving Areas, page 3-10

Cattle Wintering Sites: Managing for Good Stewardship

**Site Considerations.** For seasonal feeding areas, shown in Figure 3.4, next page, implement the following practices:
♦ locate facilities away from yard drain inlets, ditches, wells and watercourses
  • at least 30.5 m from wells (*Public Health Act*)
  • at least 30 m from a watercourse or high tide watermark (*Agricultural Waste Control Regulation*)
♦ locate such that contaminated runoff cannot reach adjacent watercourses
♦ locate where feeding site leachate cannot reach ground water
  • do not choose sites where ground water is near the surface or that have soils that will allow leachate to easily move to ground water
♦ locate in areas that are not subject to flooding nor receive significant runoff
♦ locate in such a way that upslope water can be diverted away from the feeding area
  • this will minimize the volume of contaminated water to contain
  • livestock may also benefit by having a drier site
locate in such a way that all contaminated runoff can be contained
♦ implement downslope diversion to direct contaminated water onto
  adjacent established perennial forage for containment to allow nutrients to
  be used by the crop in the next growing season
♦ for small volumes, berm to direct or contain contaminated water onsite
♦ for large volumes, construct an impervious pond to contain the
  contaminated water

Watering. When watering livestock outdoors, implement the following
  practices:
♦ use an off-stream watering system to ensure low risk (A in Figure 3.4)
  ➔ see Livestock Water, page 9-13
♦ where an off-stream watering system is not feasible, use an access to a
  watercourse that is low impact (B in Figure 3.4)
  ➔ see Watering Livestock Directly from Watercourses, page 9-13

Bedding. When bedding livestock outdoors, implement the following
  practice:
♦ situate bedding sites to keep manure accumulations away from surface
  water and riparian areas
  • provide windbreaks that lure livestock away from treed riparian areas
  • locate water and feed sites to minimize the use of problem bedding
    areas
♦ if used, collect woodwaste bedding at least once a year (preferably in the
  spring) and handle appropriately ➔ see Woodwaste, page 2-27

Feeding. When feeding outdoors, implement the following practices:
♦ clean up wasted or spilled feed before it becomes a pollution risk
♦ locate feeders to ensure that manure build up around feeders does not
  pollute watercourses
♦ meet crop needs by moving feeding locations or portable feeders around
  the site as required to provide good manure distribution
♦ get approval for location of permanent feeders from MOE (Agricultural
  Waste Control Regulation)
Figure 3.4 An Environmentally-Sound Seasonal Feeding Area

**Perennial vs. Annual Crops on Seasonal Feeding Areas.** For seasonal feeding areas with *perennial* forage crops, feeding intensity is normally low to prevent damage to the crop. Generally, the practices suggested above provide appropriate environmental protection. However, where a perennial crop is going to be plowed under the following year and feeding intensity is to be high, treat the feeding site as an annual crop site (see below).

For seasonal feeding areas with *annual* forage crops, feeding intensity may not be governed by crop damage concerns. It is possible for these sites to take on some characteristics of confined feeding areas (e.g., dense manure pack, bare soil). In these cases, manage the areas similar to confined areas. ➔ see Confined Livestock Areas, page 3-8

**Grazing** Grazing areas vary from intensively-managed pastures to rangelands. Maintain the health of grazing areas by following the practices outlined in the [Grazing Management Guide publication](http://www.for.gov.bc.ca/hra/Practices/index.htm).
Grazing Management Guide is a publication that forms a part of the Environmental Farm Plan series on Beneficial Management Practices. Its purpose is to provide a checklist and guidelines for protecting pasture and range health. Is recommended to be used by producers having either pastures or private rangelands or who graze Crown land under a grazing lease. Table 3.3, next page, gives four basic pasture and range assessment questions that direct producers to the use of this publication.

**Manure Nutrients.** If rainfall is adequate or if irrigation is used, pastures may have high productivity, and could support high stocking rates for long periods. Because grazing animals do not excrete more nutrients than they consume, manure nutrients produced during grazing will not exceed amount needed by the crop being grazed. As a result, collection and storage of manure will not be required and effective management will move livestock to distribute manure evenly over the grazed area. Manage sites experiencing contaminated runoff to ensure that nutrients stay on the pasture.

If manure distribution is uneven, as is possible around supplemental feeding areas, manure may have to be redistributed. If fertilizer is applied in addition to manure excreted during grazing, care must be used to not exceed crop needs. 

**Nutrient Management Reference Guide**

With intensively-managed pastures, such as grazing livestock on irrigated pastures, implement the following practices:

♦ use livestock waterers where feasible
♦ although access to watercourses is allowed, it is recommended that livestock waterers be installed on intensively managed pastures and that accessible portions of the watercourse be fenced off where appropriate

**Watering Livestock Directly From Watercourses**

♦ prevent stream banks from being trampled upon to protect fish habitat and stream banks from erosion

⇒ see Watering Livestock Directly from Watercourses, page 9-13

♦ ensure that contaminated pasture runoff does not enter any watercourse

⇒ see Runoff, page 9-42

♦ ensure no leachate is allowed to reach ground water

♦ do not graze livestock on saturated soils because they are easily compacted

♦ manage grazing to maintain a crop stubble that will filter runoff and hold soils in place

♦ place salt and mineral blocks or sources to lure livestock away from watercourses and sensitive areas

♦ harrow pastures regularly to break up manure clods, particularly in drier regions

For information on rangelands, refer to:

⇒ Rangeland Handbook for BC
⇒ Grassland Monitoring Manual for British Columbia: A Tool for Ranchers
⇒ Land Management Guide for Horse Owners and Small Lot Farmers

**Weeds.** Weeds may be spread by grazing livestock. Control weeds before they become a problem. ⇒ see Weeds, page 5-9
**Table 3.3 Basic Pasture and Range Assessment Questions**

1. **Do Desirable Plants Make Up More Than One-half of the Vegetation Cover or Weight?**

Desirable plants are those that contribute positively to the management objectives of your site, plants that:

- are readily consumed and persistent
- provide consistent amounts of forage (high tonnage)
- are perennial, except in tame pastures that are specifically being managed for annual species
- prohibit the introduction or spread of invasive plants; and
- provide enough litter and residue to conserve soil moisture and maintain soil stability

Undesirable plants can include those that are invasive, poisonous and those that crowd out desirable species. In tame pasture, undesirables may include woody invaders (rose, aspen, snowberry etc.) and those that are typically not eaten by most livestock or cause undesirable side effects when eaten.

<table>
<thead>
<tr>
<th>A Southern Interior grassland composed primarily of low growing, relatively non-</th>
<th>A Southern Interior grassland composed of more than one-half highly productive and desirable large bunchgrasses.</th>
</tr>
</thead>
<tbody>
<tr>
<td>An example of a Peace River aspen stand showing the removal of desirable tall forbs, grasses and shrubs. All that remains are low growing forbs that</td>
<td>Peace River aspen stand showing an abundance of desirable plants including highly productive grasses, forbs and shrubs.</td>
</tr>
</tbody>
</table>

**Examples of Desired Plant Communities**

2. **Does Leaf Length, Seed Production, Colour, and Overall Productivity of Desirable Plants Indicate Strong Vigour?**

Plant vigour is reflected primarily by the size of a plant and its parts in relation to its age and the environment in which it is growing. However, periodic drought in dry land environments will lower the apparent vigour and annual productivity of desired plants. Plants with low vigour have a greater potential to be replaced by weedy invasive and low quality or poisonous plants.

<table>
<thead>
<tr>
<th>Peace River aspen stand showing poor vigour, productivity and a loss of desirable tall forbs and</th>
<th>Peace River aspen stand showing excellent vigour, productivity and a mixture of desirable tall forbs, grasses and shrubs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern Interior bunchgrass grassland showing poor vigour, productivity and a lack of desirable forbs</td>
<td>Southern Interior bunchgrass grassland showing excellent vigour, productivity and a dominance of large, more robust bunchgrasses.</td>
</tr>
</tbody>
</table>
### Examples of Plant Vigour

#### 3. Is Litter and Plant Residue Fairly Abundant and is Some of it Composed of Desirable Plants?

Litter and standing plant residue (dead material), in various states of decay, provides additional surface cover that:
- promotes nutrient cycling by providing organic matter to the soil
- reduces soil erosion by wind and water including reducing raindrop impact
- increases water infiltration into the soil by slowing runoff and providing a pathway into the soil profile
- promotes moisture retention by reducing evaporation

In order for litter and plant residue to be rated as fairly abundant, approximately 25 percent of the standing forage mass should either be dead or consist of dying leaves and stems:
- on tame pastures, less than 25 percent should either be dead or consist of dying leaves and stems
- anything greater than 25 percent may be excessive – too much litter and standing plant residue dead material will reduce the feed of the forage consumed and animal intake, as well as inhibits new plant shoot growth and seedling emergence.

#### Examples of Plant Litter

| Southern Interior grassland with relatively little litter. | Southern Interior bunchgrass grassland with fairly abundant litter and plant residue (>25%), some of which is composed of desirable plants. |

### Examples of Soil Movement or Loss

#### 4. Is the Area Free of Evidence Indicating Soil Movement or Loss?

When managing your grazing lands it is extremely important to prevent human caused soil movement or loss by maintaining adequate plant cover and minimizing the amount of exposed (bare) soil. Any loss of soil will lower the productivity of a site by removing finer soil particles like clays, silts and organic matter all of which are integral in maintaining soil fertility and a sites moisture holding capacity.
- soil compaction should be minimized as it decreases the amount of water available to plants by reducing water infiltration into the soil profile

**Evidence of soil compaction:**
- push a metal rod, pencil, or knife into the soil and interpret the ease of penetration
- compare in-field resistance to penetration with resistance found at a grazed fenceline
- compacted soil layers will increase the amount of resistance encountered
- the more noticeable the difference in resistance, the greater the compaction is in that pasture

**Evidence of soil movement or loss includes:**
- the presence of debris dams of plant residue that build up at obstructions or span between obstructions (sheet erosion)
- the presence of rills, which are small incised channels that run parallel to one another down a slope, indicate that serious soil loss is occurring
- the deposition of heavier soil particles downwind of obstructions such as fencelines, buildings and vegetation

#### Examples of Soil Movement or Loss - Rills, Gullies and Pedestaling

| Example of rills on a Southern Interior grassland. | Example of a gully on a Peace River pasture. |

★ Pastures and ranges that do not have these features should refer to the *Grazing Management Guide* publication for assistance in more detailed assessment and management ideas to improve.
Manure is a valuable by-product of livestock operations. However, to realize its potential value and to avoid pollution problems, well-planned manure handling and storage systems are essential.

**MANURE HANDLING AND STORAGE ENVIRONMENTAL CONCERNS**

Primary environmental concerns related to manure handling and storage are:
- manure handling, spillage, storage facility leakage, or overtopping that results in soil or water pollution, or impacts to habitat
- insufficient storage that requires manure spreading during high-risk seasons that results in water pollution
- inappropriate field storage that results in water pollution
- release of methane (CH₄) and nitrous oxide (N₂O), greenhouse gases that contribute to climate change
- release of ammonia (NH₃), volatile organic compounds (VOC) and nitrogen oxides (NOₓ) which can chemically produce secondary particulate that results in pollution, human health concerns and visibility reduction
- release of odours associated with ammonia and other contaminants
- release of hydrogen sulphide and other air contaminants that result in air pollution
  - see Chapter 6, Soil Amendments, regarding manure application to land

For information on these concerns:
- see Impacts on Biodiversity and Habitat, page 7-8, refer to Farm Activities and Impacts
- see Soil Quality Factors, page 8-2, refer to Contaminants, to Micronutrients and Metals, and to Salts
- see Water Quality and Quantity Factors, page 9-2, refer to Contaminants, and to Oxygen Demand
- see Air Quality Factors, page 10-1, refer to Contaminants, to Dust and Particulates, and to Odours
- see Climate Change Factors, page 12-1
MANURE HANDLING AND STORAGE LEGISLATION

The following is a brief outline of the main legislation that applies to manure handling and storage.

See page A-1 for a summary of these and other Acts and Regulations

Drinking Water Protection Act

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).

- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system.

Environmental Management Act

The Code under the Agricultural Waste Control Regulation has specific requirements regarding manure storage and use.

- Section 4: manure may be stored on a farm only if it is produced or used on that farm.
- Section 5: when manure is stored, it must be stored in a storage facility, in field storage or, in the case of fur bearing animals, under their outdoor pens.
- Section 6: a manure storage facility must be of sufficient capacity to store all manure for a period needed to allow its application as a fertilizer, prevent the escape of any waste that causes pollution, and be maintained in a manner to prevent pollution.
- Section 7: a manure storage facility must be located at least 15 m from any watercourse and at least 30 m from any source of water for domestic purposes.
- Section 8: solid manure may be stored on a field for 2 weeks or less if it is used within 2 weeks and stored to prevent pollution; it may be stored for no longer than 9 months if it is located at least 30 m from any watercourse or any source of water used for domestic purposes, and stored in a manner that prevents pollution.
- Section 9: field-stored manure must be covered (Oct. 1st to April 1st) in areas that receive a total average precipitation more than 600 mm during Oct. 1 to April 30 (refer to Appendix Figure B.1, page B-2).
- Section 10: for fur bearing animals, manure can be stored for up to 9 months if under pen storage is at least 15 m from a watercourse and at least 30 m from any source of water used for domestic purposes and stored in a manner that prevents pollution.

The Spill Reporting Regulation requires spills of a polluting substance (including manure) be reported immediately to Provincial Emergency Program (PEP) at 1-800-663-3456 (24 hour service). Report spills of manure greater than 200 kg or 200 litres.

Public Health Act

This Act prohibits activities that may cause a health hazard:
Section 15: a person must not willingly cause a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard

The Act also has conditions under the Public Health Act Transitional Regulation:

Section 18: separation distance of wells to be at least 30.5 m from any probable source of contamination (a probable source could include manure)

**Fisheries Act** This Act has two sections of importance to manure management:

- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substance could include manure)
- Section 38(4): requires reporting infractions of Section 36

**Migratory Birds Convention Act** This Act has a section of importance to manure management:

- Section 35(1): prohibits the deposit of any substance harmful to migratory birds to any area frequented by migratory birds

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**MANURE HANDLING AND STORAGE BENEFICIAL MANAGEMENT PRACTICES**

Comply with applicable manure related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

→ see Chapter 6, Soil Amendments, regarding manure use (i.e. application to land)

**Manure Handling** Minimize the risk of causing pollution when manure handling during cleanup of pens or barns and moving to or from storage facilities by implementing the following practices:

- contain manure during transport within equipment to avoid spills
- ensure manure is not carried onto public roads by equipment tires
- limit the amount of manure handling near watercourses
- in case of a pipe break when piping manure near watercourses, have a containment method, such as a double-walled pipe within 10 m of the watercourse (suggested) and a low pressure switch to turn off the pump
- where manure is moved from barns or pens to storage facilities by scraping over outside hard surfaces, ensure runoff from these surfaces is collected
- have a manure spreading plan → see Nutrient Application, page 6-8
- where possible, use air emission and odour-reduction practices
  → see Air Emissions, page 10-5,
  → see Odours, page 10-13

**Manure Storage** Storage of manure is necessary during times of the year when manure cannot be applied to cropland, either because the crop will not be able to utilize the nutrients, or the risk of causing pollution is too high.
Storage Facilities. A storage facility is a permanent structure designed and operated to contain manure and other agricultural wastes in an environmentally sound manner and sized to hold wastes until they can be used as a fertilizer.

Implement the following practices for all manure storage structures:

- only store manure produced, or that will be used, on the farm (do not store manure produced off the farm that will be used off the farm, Agricultural Waste Control Regulation)
- have facilities designed by a professional engineer whether of earthen, concrete or metal construction
- size facilities to provide storage for the manure, any contaminated water that may enter, and if not roofed, precipitation
- size to enable the wastes to be stored until it can be spread as a fertilizer
  ➔ see Manure Storage Sizing, page 3-27
- cover solid or semi-solid manure storages in high rainfall climates (greater than 600 mm total winter precipitation)
  ➔ see Appendix B.1 for a map showing high and low precipitation areas, page B-1
- incorporate leak detection with semi-solid and liquid storages as shown in Figure 3.5, next page
- incorporate secondary containment with liquid storages
- locate on a well-drained graded site, to divert clean runoff away (collecting clean water is an expense to be avoided)
- protect from 100-year flood events
- establish and maintain an adequate buffer between manure storage and watercourses to prevent wastes or leachate from polluting
  ➔ see Buffers, page 11-4

Leak Detection. Good management of semi-solid and liquid manure storages requires a means of monitoring for leaks. If a storage facility is built on fine-textured or “clayey” soil, install a tile line draining to a dry observation well underneath the structure. Check the observation well for the presence of leachate at least four times a year. Implement the following practices (see Figure 3.5, next page):

- install a tile line under the middle of the facility, and
- under the facility at the toe of the sloping wall for lagoon type, or
- about 1 m (suggested) inside the perimeter for concrete or steel walled type facilities
- install a tile line for every 3,000 m² of floor area (suggested)

In coarse-textured soils, lines underneath storages may not detect leakage because percolation paths tend to be more vertical than in less permeable soils. Complete monitoring would include regular testing for ammonia and nitrate levels in ground water around the facility.

Secondary (Failure) Containment. If a structural failure of a liquid manure storage facility would result in manure entering a watercourse, install some form of secondary containment. Secondary containment can be as simple as a berm away from the manure storage located and sized such that any manure
that might escape from the failed structure could be contained behind the berm. Sizing will normally be equal to the volume of manure stored.

![Diagram of Leak Detection Under a Manure Storage Facility]

**Figure 3.5  Leak Detection Under a Manure Storage Facility**

**Solid Manure Storage** Solid manure has a solid content of 20% or more and retains its shape when piled. Uncovered solid manure structures are suitable only if runoff from such storages is collected. Typical features of solid manure storage are shown in Figure 3.6, page 3-27. In addition to the practices described in Manure Storage, page 3-23, implement the following practices:

- construct a concrete base and a curbed sidewall along at least one side to allow easy unloading of the facility
- in high rainfall climates, construct a sump to collect and store the contaminated leachate for future land spreading

**Field Storage of Solid Manure.** Field storage is temporary storage, used just prior to spreading on cropland. Under sections 8 and 9 of the Code under the Agricultural Waste Control Regulation, only solid manure may be piled in a field storage area, and storage time is to be limited. Field storage is not meant to replace a storage facility and storage directly on the ground is not recommended in high rainfall climates and in areas with high water tables.

Field storage is the least desirable method of storing manure due to the inherent difficulty in containing leachate. Because constant attention is required to operate and monitor a covered field storage site in a manner that does not cause pollution, only use such systems until a permanent facility can be built.
Note: The Code under the Agricultural Waste Control Regulation has different requirements for field stored solid manure depending on what time of year the manure is stored in the field (such as in the winter or in the summer) and if the manure is stored for more than or less than 2 weeks. Refer to the Code under the Agricultural Waste Control Regulation in Appendix A for details.

For field storage of solid manure implement the following practices:
- locate field storage away from ditches, wells and watercourses
- at least 30.5 m from wells (Public Health Act)
- at least 30 m from a watercourse if stored more than two weeks (Agricultural Waste Control Regulation)
- 30 m or more from a water intake used for domestic purposes (suggested)
- locate on a graded site to divert runoff away
- locate on fine-textured or “clayey” soils to protect ground water from leachate (avoid locating on coarse textured or gravely soils)
- protect from possible flooding events
- build up piles quickly, then cover and leave until used; field storages are not meant to be loaded on a daily or weekly basis
- cover with a tarpaulin or plastic to keep rainwater from entering the pile and to prevent the escape of effluent
- the Code under the Agricultural Waste Control Regulation requires piles to be covered (Oct 1st to April 1st) where total average precipitation is greater than 600 mm from Oct. 1st to April 30th

Semi-Solid Manure Storage

Semi-solid manure has less than 20% solids, but does not flow freely as liquid manure. In addition the practices described in Manure Storage, page 3-23, implement all of the following practices:
- construct reinforced concrete walls or adequately strong wooden walls along at least three sides, to contain manure
- construct concrete floor sealed at the walls to provide manure tight storage and prevent the entrance of ground water or runoff
- in areas with high water table, construct entirely above ground to minimize inward seepage of ground water
- construct an adequate roof to keep out rain and snow particularly in areas with high annual or seasonal precipitation (unless extra size is less expensive than the roof or extra dilution is of value)
- in drier interior regions, an uncovered storage structure may be suitable
- in high rainfall climates, construct a sump to collect and store the contaminated leachate for future land spreading
- if roofed or enclosed, have ventilation to prevent any accumulation of hazardous gases and to aid in the drying of the wastes
- construct access doors or bulkheads of tight fitted tongue-and-groove pressure treated timbers and collect any seepage
- have a system to detect leaks
- construct a suitable concrete slab area for tractor and manure spreader activity, sloped away from the building so that water on the slab does not enter the storage area
- if runoff becomes contaminated, see Runoff, page 9-42
Liquid Manure Storage

Liquid manure storage structures are used for containing liquid wastes such as manure or contaminated water. In addition the practices described in Manure Storage, page 3-23, implement the following practices:

- construct of sulphate-resistant concrete with a compressive strength of 20 MPa or greater (suggested), plastic, glass-lined metal, etc.
- if very large, construct cross walls and/or baffles to facilitate agitation
- if constructed entirely or partially above grade
- ensure valves close tightly and install backup valves
- install a manure level indicator that is readable from the ground
- if constructed entirely below grade and covered
- install childproof access ports weighting 20 kg or more (suggested)
- divert clean runoff away from the tank
- have a system to detect leaks
- install an auto shut off for manure transfer tanks
- have secondary containment
- limit uncovered surface area to reduce odour and fly problems

Manure Storage Sizing

Size a storage facility to allow all manure generated on the farm to be used as a fertilizer with little chance of causing pollution. Note that manure storage sizing
assumes the facility will be empty, or near empty, at the start of the no-spread season.

**Estimating Daily Manure Volume.** The average daily livestock waste volumes produced by livestock type or class may be obtained using the standard values listed in Table 3.4, page 3-29. More accurate estimates can be obtained by measuring actual manure volume produced.

**Determining Storage Duration.** Manure storage requirements vary depending on the farm location in the province. Typically, 6 months (180 days) of storage are required for the Fraser Valley and Vancouver Island. Other parts of BC may need 7 months (210 days) or more of storage. Variations within regions depend on crops grown and field accessibility factors such as soil type, soil temperature, and local rainfall. Storage requirements are reduced on farms where manure is spread on grasslands on well drained soils.

→ see Appendix B.1, page B-2, for BC map showing recommended storage periods

**Determining Manure Storage Size.** Size storages using Worksheet #2, page 3-30, for liquid manure or Worksheet #3, page 3-32 for solid manure. Using the appropriate worksheet, follow the steps below:

- Step 1: estimate daily manure volume
- Step 2: determine manure storage required
- Step 3: determine total storage required
- to determine contaminated runoff to be collected for the duration of time that manure spreading is not possible, use Worksheet #11, page 9-47
- estimate the amount of other contaminants, such as silage leachate
- Steps 4 and 5: determine the effective depth and size the storage facility

Note that if a chosen width and depth does not give the preferred length, choose different width(s) and/or depth(s) until the calculated length is acceptable. For the same depth, a wider width will reduce the length; a narrower width will increase the length.

 môn Sizing Dairy Manure Storage Facilities
### Table 3.4 Average Daily Livestock Waste Production and Suggested Storage

<table>
<thead>
<tr>
<th>Class of Animal</th>
<th>Waste Production</th>
<th>Liquid&lt;sup&gt;1&lt;/sup&gt; Manure Storage</th>
<th>Solid Manure Storage&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Liquid Leachate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beef Cattle</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cow or Bred Heifer (to 230 kg)</td>
<td>28</td>
<td>40</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Calves (to 230 kg)</td>
<td>7</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yearlings (to 340 kg)</td>
<td>14</td>
<td>20</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Heavy Feeders (to 500 kg)</td>
<td>21</td>
<td>31</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Dairy Calves (0 to 3 months old)</td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy Calves (3 to 6 months old)</td>
<td>8</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heifers (6 to 15 months old)</td>
<td>16</td>
<td>22</td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td>Heifers (15 to 26 months old)</td>
<td>24</td>
<td>35</td>
<td>25</td>
<td>7</td>
</tr>
<tr>
<td>Dairy Cow – free stall (avg. 640 kg)</td>
<td>60</td>
<td>75</td>
<td>63</td>
<td>12</td>
</tr>
<tr>
<td>Dairy Cow – tie stall (avg. 640 kg)</td>
<td>60</td>
<td>67</td>
<td>65</td>
<td>10</td>
</tr>
<tr>
<td>Dairy Cow – loose housing (avg. 640 kg)</td>
<td>60</td>
<td>22 to 45</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td><strong>Dairy Cattle</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy Calves (0 to 3 months old)</td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy Calves (3 to 6 months old)</td>
<td>8</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heifers (6 to 15 months old)</td>
<td>16</td>
<td>22</td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td>Heifers (15 to 26 months old)</td>
<td>24</td>
<td>35</td>
<td>25</td>
<td>7</td>
</tr>
<tr>
<td>Dairy Cow – free stall (avg. 640 kg)</td>
<td>60</td>
<td>75</td>
<td>63</td>
<td>12</td>
</tr>
<tr>
<td>Dairy Cow – tie stall (avg. 640 kg)</td>
<td>60</td>
<td>67</td>
<td>65</td>
<td>10</td>
</tr>
<tr>
<td>Dairy Cow – loose housing (avg. 640 kg)</td>
<td>60</td>
<td>22 to 45</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Milk centre wastes per milking cow</td>
<td>22 to 45</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ducks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(avg. 1.4 kg)</td>
<td>0.15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Goats</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(avg. 64 kg)</td>
<td>2.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Horse</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(avg. 450 kg)</td>
<td>26.1</td>
<td>56.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Poultry Eggs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pullets – cage housing</td>
<td>0.039</td>
<td>0.039</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pullets – floor housing</td>
<td>0.039</td>
<td>0.059</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Layer</td>
<td>0.13</td>
<td>0.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broiler Breeder Layer – cage housing</td>
<td>0.14</td>
<td>0.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broiler Breeder Layer – floor housing</td>
<td>0.14</td>
<td>0.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Poultry Meat</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broiler Breeder Pullets</td>
<td>0.049</td>
<td>0.077</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broiler Chicken</td>
<td>0.054</td>
<td>0.096</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roaster Chicken</td>
<td>0.057</td>
<td>0.090</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turkey Broiler</td>
<td>0.20</td>
<td>0.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turkey Heavy Hen</td>
<td>0.29</td>
<td>0.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turkey Heavy Tom</td>
<td>0.33</td>
<td>0.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rabbits</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doe and Litter</td>
<td>0.71</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sheep</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ewe or Ram</td>
<td>2.8</td>
<td>6.8</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td><strong>Hogs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry Sow, Boar or Gilts</td>
<td>11.3</td>
<td>15.8</td>
<td>13.6</td>
<td></td>
</tr>
<tr>
<td>Nursing Sow and Litter</td>
<td>16.8</td>
<td>23.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nursery Pigs (5 to 20 kg)</td>
<td>1.8</td>
<td>2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grower Pigs (20 to 60 kg)</td>
<td>4.5</td>
<td>6.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finisher Pigs (60 to 100 kg)</td>
<td>8.6</td>
<td>12.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grower Finisher Pigs (20 to 100 kg)</td>
<td>7.2</td>
<td>10.1</td>
<td>10.1</td>
<td></td>
</tr>
<tr>
<td><strong>Veal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(avg. 91 kg)</td>
<td>5.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup> Liquid manure production includes typical spilled drinking water and wash water.

<sup>2</sup> Some solid manure storages will have a liquid leachate which must be stored separately.

<sup>3</sup> Including bedding.

<sup>4</sup> This is a typical range – less milking centre waste is produced per cow for large milking herds compared to small herds.
**Worksheet #2 Sizing Liquid Manure Storage Workbook Question 103**

**Question:** A dairy farmer in Enderby wants to build a manure storage facility to hold manure from a 100 milking cow herd, milking centre wastes, 512 m³ of contaminated runoff and 35 m³ of silage juices for 180 days. What length should the uncovered facility be, if 3 m deep and 20 m wide?

What size of liquid manure storage is required for this livestock operation?

**Information:**
- Desired storage duration (select site): Enderby
- Precipitation on the site from Oct 1 to April 30: 0.456 m
- Storage depth: 3 m
- Storage width: 4 m
- Runoff to be stored from roofs and confinement yards - from Worksheet 11: 512 m³
- Other liquid wastes to be stored: 35 m³

**Calculation:**

**Step 1** Establish daily manure volume

**Equation:**

\[
\text{Daily Manure Production for type and Class of } \times \text{Animals Daily Rate} = \text{Farm daily manure volume}
\]

<table>
<thead>
<tr>
<th>Class of Animal</th>
<th>Average Number on Farm</th>
<th>Liquid Manure Storage Litres per day per animal</th>
<th>Total Storage Required Litres/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy - Calves (0 to 3 months old)</td>
<td>10 x 6</td>
<td>= 60</td>
<td></td>
</tr>
<tr>
<td>Dairy - Calves (3 to 6 months old)</td>
<td>10 x 11</td>
<td>= 110</td>
<td></td>
</tr>
<tr>
<td>Dairy - Heifers (6 to 15 months old)</td>
<td>28 x 22</td>
<td>= 616</td>
<td></td>
</tr>
<tr>
<td>Dairy - Heifers (15 to 26 months old)</td>
<td>33 x 35</td>
<td>= 1155</td>
<td></td>
</tr>
<tr>
<td>Dairy - Cows – free stall (avg. 640 kg)</td>
<td>20 x 75</td>
<td>= 1500</td>
<td></td>
</tr>
<tr>
<td>Dairy - Cows – free stall (avg. 640 kg)</td>
<td>100 x 75</td>
<td>= 7500</td>
<td></td>
</tr>
<tr>
<td>Dairy - Milk centre wastes per milking cow</td>
<td>100 x 30</td>
<td>= 3000</td>
<td></td>
</tr>
</tbody>
</table>

Farm daily manure volume

**Equation:**

\[
\text{Farm Daily Manure Production} = \text{Sum of the Daily Manure Production For Each Livestock Type or Class}
\]

Converted to m³:

\[
\frac{13941 \text{ Litres/day}}{10} = 13.9 \text{ m}^3/\text{day}
\]

**Step 2** Determine manure storage required

**Equation:**

\[
\text{Manure Storage required} = \text{Farm daily manure production} \times \text{Days of storage required}
\]

\[
= \frac{13.94}{11} \text{ m}^3/\text{day} \times \frac{180}{1} \text{ days} = \frac{2509.38}{12} \text{ m}^3
\]

**Step 3** Determine total storage required

**Equation:**

\[
\text{Total Storage required} = \text{Manure Storage required} + \text{Contaminated runoff (liquid storage only)} + \text{Other Liquid Wastes}
\]

\[
= \frac{2509}{12} \text{ m}^3 + \frac{512}{5} \text{ m}^3 + \frac{35}{6} \text{ m}^3 = \frac{3056.38}{13} \text{ m}^3
\]
### Step 4
Determine effective storage facility for rectangular tanks

**NOTE:** If calculated length is unsuitable, choose different width or depth until size is suitable.

| Equation: |
|-----------------|-----------------|-----------------|
| Effective storage depth = Storage depth - Precipitation at the site - Safety freeboard (normally 0.2 m) |
| = 3.0 m - 0.456 m - 0.2 m = 2.3 m |

| Equation: |
|-----------------|-----------------|-----------------|
| Storage length = Total storage length ÷ Effective depth ÷ Storage width |
| = 3056 m³ ÷ 2.3 m ÷ 20 m = 65.2 m |

**Answer:** An uncovered manure storage facility for this farm should be 3.0 m deep by 20.0 m wide and 65.0 m long to hold precipitation that falls directly into the storage and 3,056 m³ of waste.
### Worksheet #3  Sizing Solid Manure Storage

**Question:** A layer farmer in Abbotsford wants to build a manure storage facility to hold litter from a 50,000 layer flock and 25,000 pullets (floor housed) for 180 days. What length should the uncovered facility be, if 3 m deep and 20 m wide?

What size of solid manure storage is required for livestock operation?

### Information:

<table>
<thead>
<tr>
<th>Desired storage duration (select site)</th>
<th>Abbotsford</th>
<th>180</th>
<th>1 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage depth</td>
<td>3</td>
<td>2 m</td>
<td></td>
</tr>
<tr>
<td>Storage width</td>
<td>20</td>
<td>3 m</td>
<td></td>
</tr>
<tr>
<td>Other solid wastes to be stored</td>
<td>0</td>
<td>4 m³</td>
<td></td>
</tr>
</tbody>
</table>

### Calculation:

#### Step 1

Establish daily manure volume

**Equation:**

\[
\text{Daily Manure Production for type and Class of Class of Livestock for each livestock type or class} = \text{Number of Animals} \times \text{Manure Production Rate}
\]

<table>
<thead>
<tr>
<th>Class of Animal</th>
<th>Average Number on Farm</th>
<th>Number of Animals</th>
<th>Manure Production Rate</th>
<th>Solid Manure Storage Litres per day per animal</th>
<th>Total Storage Required Litres/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eggs - Layer</td>
<td>50000</td>
<td>x</td>
<td>0.13</td>
<td>= 6500</td>
<td></td>
</tr>
<tr>
<td>Eggs - Pullets – floor housing</td>
<td>25000</td>
<td>x</td>
<td>0.059</td>
<td>= 1475</td>
<td></td>
</tr>
<tr>
<td>Chicken - Broilers</td>
<td>5000</td>
<td>x</td>
<td>0.21</td>
<td>= 0</td>
<td></td>
</tr>
<tr>
<td>Calf - Steers</td>
<td>2000</td>
<td>x</td>
<td>0.20</td>
<td>= 0</td>
<td></td>
</tr>
<tr>
<td>Pig - Sows</td>
<td>5000</td>
<td>x</td>
<td>0.05</td>
<td>= 0</td>
<td></td>
</tr>
<tr>
<td>Sheep - Ewes</td>
<td>1000</td>
<td>x</td>
<td>0.01</td>
<td>= 0</td>
<td></td>
</tr>
<tr>
<td>Goat - Kids</td>
<td>500</td>
<td>x</td>
<td>0.005</td>
<td>= 0</td>
<td></td>
</tr>
<tr>
<td>Horse - Foals</td>
<td>50</td>
<td>x</td>
<td>0.001</td>
<td>= 0</td>
<td></td>
</tr>
<tr>
<td>Other solid wastes</td>
<td>0</td>
<td>x</td>
<td>0</td>
<td>= 0</td>
<td></td>
</tr>
</tbody>
</table>

**Farm daily manure volume**

**Equation:**

\[
\text{Farm Daily Manure Production} = \text{Sum of the Daily Manure Production For Each Livestock Type or Class}
\]

<table>
<thead>
<tr>
<th>Farm daily manure volume Converted to m³</th>
<th>7975</th>
<th>8</th>
<th>Litre/day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8.0</td>
<td>9</td>
<td>m³/day</td>
</tr>
</tbody>
</table>

#### Step 2

Determine manure storage required

**Equation:**

\[
\text{Manure Storage required} = \text{Farm daily manure volume} \times \text{Days of storage required}
\]

\[
8.0 \times 9 \times 180 = 1435.5 \text{ m}³
\]

#### Step 3

Determine total storage required

**Equation:**

\[
\text{Total storage required} = \text{Manure storage required} + \text{Other solid wastes}
\]

\[
1435.5 + 0.0 = 1435.5 \text{ m}³
\]
Step 4  Determine effective storage facility for rectangular tanks

NOTE: If calculated length is unsuitable, choose different width or depth until size is suitable.

<table>
<thead>
<tr>
<th>Effective storage depth</th>
<th>Storage depth</th>
<th>Safety freeboard (normally 0.2 m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0 m</td>
<td>2 m</td>
<td>0.2 m</td>
</tr>
</tbody>
</table>

Equation: \( \text{Effective storage depth} = \frac{\text{Storage depth}}{\text{Safety freeboard}} \)

Answer: An uncovered manure storage facility for this farm should be 3.0 m deep by 20.0 m wide and 25.6 m long to hold 1,436 m³ of waste. Note: an uncovered solid manure storage is not recommended due to the risk of spontaneous combustion. Also precipitation falling in this manure storage facility would generate contaminated runoff that would need to be collected and handled as a liquid waste. A roof on the storage facility to exclude precipitation is recommended.

Manure Gas Emissions Reduction

Carefully plan and manage the handling, composting, spreading or storage of all wastes to avoid the creation of gas emissions and nuisance conditions.

Implement the following practices to minimize the release of emissions from manure:

♦ choose manure storage options that will reduce the release of emissions, such as:
  ● using dry rather than wet storage methods when there is the option
  ● use enclosed storages that reduce air movement across the surface of manure storage

♦ minimize the handling and agitation of manure during storage

♦ minimize amount of bedding in manure, such as straw or woodchips

♦ keep storage tanks cool by either insulating or placing below ground

♦ for liquid manures, separate urine and feces immediately upon excretion to reduce ammonia emissions

♦ do not wet or re-wet solid manure to avoid N₂O emissions

♦ incorporate vegetative buffers around manure storage facilities
  ➔ see Buffers, page 11-4

♦ use methane collection and utilization techniques such as anaerobic digestion
  ➔ see Climate Change Mitigation Beneficial Management Practices, page 12-10, and refer to On-Farm Energy Production

Farm Practices - Manure Storage and Use

Covered Storage. Cover storages, particularly for liquid manure, to reduce gaseous emissions that are air contaminants and can lead to odours. Liquid systems can also be covered with permeable covers, such as mineral oil, straw or peat on tanks or lagoons. A secondary but major benefit in covering storages for all types of waste is that snow and rain are excluded, thereby reducing the amount of material needed to be both handled and stored. In addition, covers
keep solid manure dry, which is necessary to prevent anaerobic conditions from occurring and to reduce the risk of leachate generation.

To reduce emissions from covered storage, use the following as guidelines:

- for solid manure storages install an impermeable cover, impermeable base, and run-off control
- for tanks and lagoons for liquid manure storage, install either an impermeable or permeable cover
- install an air-inflated fabric roof system or floating cover on an open tank
- use bottom loading tanks for liquid manure storage to minimize aeration

Table 3.5 shows effectiveness of manure cover options in reducing emissions for various air contaminants.

<table>
<thead>
<tr>
<th>Cover</th>
<th>Type</th>
<th>Effectiveness (%)</th>
<th>Life Expectancy</th>
<th>Relative Capital Cost (1 = most expensive)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odour</td>
<td>H2S</td>
<td>NH3</td>
<td></td>
</tr>
<tr>
<td>Inflatable plastic</td>
<td>95</td>
<td>95</td>
<td>95</td>
<td>10 years</td>
</tr>
<tr>
<td>Floating plastic</td>
<td>95</td>
<td>95</td>
<td>95</td>
<td>10 years</td>
</tr>
<tr>
<td>Natural crust</td>
<td>10 – 90**</td>
<td>10 – 90**</td>
<td>10 – 90**</td>
<td>2 to 4 months</td>
</tr>
<tr>
<td>Straw</td>
<td>40 - 90</td>
<td>80 - 95</td>
<td>25 - 85</td>
<td>Up to 6 months</td>
</tr>
<tr>
<td>Geotextile (non-woven, 6.35 mm thick)</td>
<td>15 - 75</td>
<td>0 - 100</td>
<td>25 - 50</td>
<td>3 - 5 years</td>
</tr>
</tbody>
</table>
Nutrition and Ration Management. Nitrogen in manure can be controlled through nutrition and ration management by formulating diets as close as possible to the requirements of the animal. For optimal growth, animals are often overfed crude proteins to meet the intake levels needed of valuable amino acids. In this case other amino acids are supplied in excess and excreted in urine as ammonia or in manure as undigested protein. Controlling the amount of Nitrogen uptake particularly in non-ruminants, including poultry and swine, can significantly reduce nitrogen losses as ammonia or during land application. This can be done by:
- reducing protein in diets and formulating diets closer to the animals needs
- supplementing diets with synthetic amino acids to allow the dietary protein (nitrogen component) to be minimized
- have a nutrition analysis done on your feeding practices

Anaerobic Manure Handling. The decomposition of manure in the absence of oxygen, known as anaerobic decomposition, results in the release of many odorous and often dangerous gases, including ammonia, hydrogen sulphide, and methane. Gas release is increased when manure is disturbed or spread. Anaerobic conditions occur within one hour when wet manure is stored in piles or as little as 15 minutes when liquid manure is stored in tanks. Manure odours from solid manure can be minimized by:
- keeping manure sufficiently dry to allow air movement and aerobic conditions through the pile to occur
- using appropriate manure timing and application techniques

Manure Treatment

Treatment is usually considered an unnecessary expense if manure can be applied directly to land. Solid liquid separation, a relatively common practice for liquid waste systems, offers advantages that improve handling. Such systems typically only remove a small fraction of the total solids and nutrients and do not significantly alter liquid storage volumes required.

Treatment systems are currently being developed that use physical, chemical and biological technologies to redistribute as many nutrients as possible from the liquid portion to solids.

Manure Treatment for Odours. In situations where well-managed manure storages or field spreading practices are not enough to control odours, manure treatment options can be considered. These could include:
- aerobic treatment and carbon reduction for liquid manure systems
- composting for solid manure
- using additives to manure or bedding for odour reduction
- using emission and odour control technology on housing or storage facilities, such as scrubbers or electrostatic precipitators

Manure Additives. Ammonia emissions can be controlled by using additives to manure, feedlots, manure piles and land applying along with manure
spreading. Additives to control ammonia emissions function by binding ammonia, by inhibiting the enzyme that breaks urea down to ammonia, or a pH balancing. Additives can be incorporated in manure slurries, manure piles or in livestock holding areas.

♦ use manure additives to reduce ammonia from liquid or dry manure
♦ manure additives are effective for the following systems:
  • storage slurry, storage dry pile or onsite in livestock holding areas

Manure Use

Manure produced on the farm can be used on-farm, by other farmers, or by the public.

Land Application. The best current option for manure disposal is in its application to crops as a fertilizer to provide nutrients or to improve soil conditions.

⇒ see Chapter 6, Soil Amendments

Compost. On-farm manure can be composted and then used on the farm or sold off the farm. Section 15 of the Code under the Agricultural Waste Control Regulation specifies composting conditions. If a producer wants to take in manure from other farms to compost and then market the compost off the farm, approvals from MOE and the Provincial Agricultural Land Commission are required.

⇒ see Compost, page 2-32.

⇒ B.C. Agricultural Compost Handbook (series of Factsheets)

Soiless Media Production. Untreated manure can be used along with other materials such as sand or sawdust to create a suitable media for landscaping or nurseries. However, in most cases composted manure is the preferred choice. Separated solids, or solids with finely chopped bedding, can also be used.

Refeeding. Recycling of some types of manure to livestock as a feed ingredient is permitted under the federal Feeds Act. Agriculture and Agri-Food Canada requires the registration of all feed ingredients and their sources. Because consumer opinion towards refeeding is generally adverse, it is recommended that this practice not be implemented for livestock feeds in BC.

Manure Spills

If a manure spill occurs, implement the following practices:

♦ construct berms or other containment measures to prevent its spread
♦ clean up the site by removing the manure and soil with excess nutrients for eventual use as a fertilizer or soil amendment

Reporting Requirement

Under the Spill Reporting Regulation, manure spills greater than 200 kg or 200 litres must be reported immediately to the Provincial Emergency Program (PEP) at 1-800-663-3456 (24hr service).

Manure Contingency Plan

Develop a contingency plan when storing any amount of manure. The plan should outline a timely and effective response to any emergencies involving the release of manure products into the environment from:
- accidental spills, such as when transporting, storing, applying or dispensing
- equipment failures
- release due to building fires or vandalism
- release due to natural events, such as forest fires, floods, or earthquakes

Contingency Plan - Template for On-Farm Planning
MORTALITY DISPOSAL

MORTALITY DISPOSAL ENVIRONMENTAL CONCERNS

Primary environmental concerns related to dead animal disposal are:
- death of livestock due to disease that results in disease spread
- holding or burial sites that result in surface or ground water or air pollution
- flies or rodents that results in a nuisance and disease transfer to people, livestock or wildlife
- attraction of predators to the site that may be undesirable for wildlife

For information on these concerns:
- see Water Quality and Quantity Factors, page 9-2, and refer to Contaminants, and to Oxygen Demand
- see Air Quality Factors, page 10-1, and refer to Odours
- see Impacts on Biodiversity and Habitat, page 7-8, and refer to Farm Activities and Impacts

MORTALITY DISPOSAL LEGISLATION

The following is a brief outline of the main legislation that applies to mortality disposal.

- see page A-1 for a summary of these and other Acts and Regulations

**Drinking Water Protection Act**

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).
- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system

**Forest and Range Practices Act**

This Act has conditions under the Range Planning and Practices Regulations:
- Section 35: requires dead livestock within 100 m of a watercourse in a community watershed be removed as soon as the holder becomes aware of the dead livestock
Environmental Management Act

The Code under the Agricultural Waste Control Regulation makes provisions for on-farm mortality disposal through composting, burial and incineration provided that the disposal activities are carried out on the farm where the animal died.

♦ Section 23: outlines the requirements for burial or incineration, including
  • burial pits located at least 30 m from any source of water used for domestic purposes
  • incineration emissions not exceed 180 mg per m³ of particulate matter and 20% opacity

♦ Section 24: outlines the requirements for composting, including
  • composting site located at least 15 m from a watercourse and at least 30 m from any source of water used for domestic purposes

The Spill Reporting Regulation requires spills of a polluting substance (including mortalities) be reported immediately to Provincial Emergency Program (PEP) at 1-800-663-3456 (24 hour service). Report spills of mortalities greater than 200 kg or 200 litres. Or report any amount, if the mortality spill contains organisms that are or that are reasonably believed to be infectious.

Public Health Act

This Act prohibits activities that may cause a health hazard:

♦ Section 15: a person must not willingly cause a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard

The Act also has conditions under the Public Health Act Transitional Regulation:

♦ Section 18: requires separation from wells to be at least 122 m from any cemetery or dumping ground (cemetery could include buried mortalities)

Wildlife Act

The provincial Wildlife Act protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

The Act makes it an offence to feed dangerous wildlife (e.g. bear, cougar, coyote, wolf).

Health of Animals Act

The Health of Animals Act enables regulatory control over Specified Risk Material (SRM), so that it does not enter the animal feed system. Regulations under this Act (enhanced feed ban) require that producers do not feed any animal products containing SRM to livestock and that abattoirs properly identify SRM to ensure that it is removed from the feed system. A permit from the Canadian Food Inspection Agency (CFIA) is required to handle, transport or dispose of cattle carcasses and certain cattle tissues if they are moved off of the farm of origin. Composting processes do not destroy SRM, therefore composted mortalities must be handled in accordance with CFIA regulations as the compost is still considered to contain SRM.
Comply with applicable mortality disposal related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

**Livestock Mortality Disposal**

Dispose of mortalities in a manner that protects surface and ground water. For livestock of all classes and types implement the following practices:

- remove dead animals from buildings and fields as soon as possible
- dead animals may be carriers of disease and, if not promptly removed, will attract wildlife, rodents and flies, and produce offensive odours
- dispose of dead animals in an approved manner within one day
- where this is not possible, freeze or store in a covered container for disposal at a more convenient time
- know the cause of death of an animal in order to select an appropriate disposal option as shown in Table 3.6, next page

Do not dispose of dead animals into manure pits or onto land during manure spreading operations. If experiencing excessive death losses contact MOE immediately for acceptable site-specific mortality disposal options.

**Off-Farm Disposal.** The default for disposal of farm animals is to manage the disposal on the farm where the animal died. If off-farm disposal is needed it should be done at an authorized facility or through an authorized service provider. Options for off farm ruminant mortality disposal must meet the regulatory requirements of the Canadian Food Inspection Agency and MOE for the handling of specified risk materials (SRM).

**On-Farm Mortality Disposal.** By following the beneficial management practices referred to on the next page for on farm disposal of any livestock species, producers should not contravene the Canadian Food Inspection Agency and MOE regulatory requirements.

**Secondary Users.** In BC a few rendering plants or secondary user operations accept dead animals. For information regarding the closest operation contact your respective livestock association. Dead animals should be stored in either airtight containers or freezers until they can be picked up by a rendering company or deadstock collection service provider. Deadstock collectors may only accept dead animals within 24 hours of their death.

**Composting.** Composting of smaller dead animals is commonly practised. Research has demonstrated the ability to safely compost larger livestock, if properly monitored. When composting mortalities, implement the following practices:

- follow general composting guidelines see Compost, page 2-26
- install moisture control options for compost piles, in high precipitation areas a roof is necessary
- use absorbent materials for the compost base and cover mortalities with a minimum of 300 mm (suggested) of woodchips, litter or straw – top and sides
space layers of small dead animals with organic matter
• larger animals may need to be cut into small pieces for efficient composting
• specified risk material regulatory requirements must be followed when composting bovine mortalities
  • CFIA Specified Risk Material Transport Permit is required to move compost offsite

Table 3.6  Mortality Disposal Options Based on Cause of Death

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>Most Preferred Method</th>
<th>Least Preferred Method</th>
</tr>
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<tr>
<td></td>
<td>Rendering</td>
<td>Composting</td>
</tr>
<tr>
<td>Disease ¹ (withdrawal time of medication not met)</td>
<td>✓²</td>
<td>✓²</td>
</tr>
<tr>
<td>Disease ¹ (no medication, or withdrawal time met)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Poisoning</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Weather (hot or cold)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Flood, Earthquake, and Forest or Building Fire</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Starvation</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

✓ means this disposal option is recommended, subject to any footnote
X means this disposal option is not recommended
¹ Depends on disease: check with veterinarian
² Depends on medication used: check with veterinarian
³ On-farm burial only at suitable sites. see Livestock Mortality Disposal, page 3-30

Landfills. In some cases, approved landfills operated by municipalities, regional districts, or private owners are made available for the disposal of dead animals. Contact site managers prior to delivering carcasses. Take large animal mortalities to landfills within one day of death. Small animal mortalities, such as poultry, may be stored in a frozen state in airtight containers for as long as required prior to disposal.

Incineration. Incineration of dead animals by open burning is an unacceptable practice. Generally, a single-chamber two-burner incinerator, or equivalent, is required. Single-burner incinerators are unlikely to meet the requirements in the Code under the Agricultural Waste Control Regulation. Where dedicated incinerators are employed for small animal disposal, implement the following practices:
• locate so that prevailing winds carry exhaust fumes away from neighbours
• be fire safe
• operate until all material is consumed
meet emission requirements

**Burying.** Consider burial pits for dead animals as the least preferred method for disposal. Contact MOE if considering on-farm burial.

If burial pits are the only option, locate them at least 30 m from any source of water used for domestic purpose (*Agricultural Waste Control Regulation*), and 30.5 m from a well (*Public Health Act*). Stagger burial sites throughout a property, not crowded together, and cover with earth; approximately 1 m (suggested) the day they are buried. Alternatives to on-farm burial will likely be necessary during the winter season in cold climates. Advice on appropriate burial practices is available in the publication [*Large Animal Disposal – On-Farm Burial Option*](#). It is highly unlikely that on-farm sites suitable for burial are available within the Lower Mainland and other flood plains throughout BC.

Place no more than 700 kg of mortalities per hectare per year in a single burial pit. This will ensure the nitrogen loading of the soil is limited to less than 50 kg of nitrogen per hectare per year. Locate only where seasonal ground water levels are at least 1 m below pit bottom and where soil type is dense. Do not dig pits on floodplains or in low-lying areas prone to seepage.

**Natural Disposal.** The deliberate disposal of livestock mortalities by natural disposal is not permitted under Section 6(3) of the *Environmental Management Act*. For any mortalities that are known to have occurred on crown or private land the farmer or rancher must make every reasonable effort to recover and properly dispose of the mortality through accepted methods (see table 3.4). It is an offence under the *Wildlife Act* to feed dangerous wildlife (bear, cougar, coyote and wolf).

---

**Mass Mortality Contingency Plan**

Develop a contingency plan for mass mortalities. The plan should provide a timely and effective response to any emergencies involving the unexpected impact to the environment, from:

- unusually high numbers of mortalities resulting from disease, vandalism, loss of electrical power, etc.
- accidental spills of livestock or livestock mortalities
- impacts due to building fires or natural events, such as forest fires, floods, or earthquakes
- impacts due to vandalism, such as poisonings

[Contingency Plan – Template for On-Farm Planning](#)
# CHAPTER 4 METRIC CONVERSIONS

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<tr>
<td>600 mm</td>
<td>24 inches</td>
</tr>
<tr>
<td>1 cm</td>
<td>0.4 inches</td>
</tr>
<tr>
<td>15 m</td>
<td>50 feet</td>
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<tr>
<td>30 m</td>
<td>100 feet</td>
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</tbody>
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Conversions in this table are rounded to a convenient number.
See Appendix E for exact conversion factor.

Values from tables and examples are not included in Metric Conversions.
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This chapter discusses crop management practices for protection of the environment. It contains introductory information on the relationship between crops and the environment. It also contains information on crop production environmental concerns, legislation and beneficial management practices related to:

- outdoor crops
- indoor and container nursery crops

**CROPS AND THE ENVIRONMENT**

The primary role of agricultural crops is to provide a food source for humans and livestock. Environmental concepts related to crops are listed in alphabetical order below.

**Buffers**

Buffers on farms are generally defined as specially managed areas used to separate farm activities from sensitive areas that may be impacted by those activities. The objective of a buffer is to intercept and retain contaminants, preventing them from reaching a sensitive area or to deliver other agricultural or environmental benefits. ➔ see Buffers, page 11-4

**Carbon Sequestration**

Plants and soil organic matter play an important role in removing carbon dioxide from the air and storing (sequestering) it. Carbon is the main component in plant material and soil organic matter. Any uptake of carbon dioxide from the air by plant material or soil reduces the effects of climate change. ➔ see Climate Change, page 12-1

**Cover Crops**

Cover cropping and relay cropping are practices that can aid in the management of pests, nutrients and soil tilth. Such practices also benefit wildlife and provide additional forage yield.

Cover crops include crops such as fall rye, barley or annual rye grass grown between plowdown and reseeding of perennial forage or hay crops or between plantings of annual crops. Cover crops are used to protect against soil erosion, to improve soil structure and soil fertility, to suppress some insect pests and weeds, and to promote higher populations of some beneficial insects. They accelerate the movement of rainwater into the soil and toward drainage systems, reducing the time free water remains on the field surface.
**Excess Nutrients**

**Impact on Crop Quality**

Under certain soil and climatic conditions, crops can take up or transform nutrients in such a way that the plant tissue can be harmful to animals. For example, grasses will “luxury consume” potassium which can lead to grass tetany in dairy cattle. In addition, nitrate-nitrogen, the form taken up by plants, can, if the concentration in soil is high enough or if there are rapid changes in moisture or temperature, accumulate in plant tissue and cause nitrate toxicity to livestock and wildlife.

**Grasses**

Forage grasses offer a unique opportunity to producers for improved nutrient management and environmental protection. Healthy grass stands build soils with good tilth and help protect soil from erosion by wind and water by binding soil particles and covering the soil surface. If soil moisture conditions are appropriate grass can take up significant amounts of nutrients.

The timing of forage harvest and the cutting height of the grass also play a critical role in the capture and filtration of runoff. Leaving longer plant stands late in the season near watercourses will help to filter suspended solids from runoff.

**Nutrient Cycle**

Crops play an integral role in nutrient cycling. For example, some crops remove excess nutrients from the soil, some capture nutrients for soil recycling that would otherwise have been lost and others capture nitrogen from the air. The nutrient cycle provides valuable sources of food and energy to the soil biota (bacteria, fungi and insects), plants and animals.

**Soil Erosion Control**

Plant roots bind soil particles together by exerting pressure and releasing glue-like organic compounds, resulting in aggregates that are more resistant to soil erosion. Plants protect soil from the erosive impact of raindrops and wind as well as from the erosive effects of overland flow by reducing the velocity of water runoff.

**Soil Structure**

Good soil structure increases soil permeability, resulting in reduced runoff flow. The growth and decay of crop roots and organic residue enhance microbial activity and population growth of soil microbes. Microbial activity improves soil structure and organic matter content.

**Runoff Filtration**

Standing crops, or crop residue attached to the soil, will decrease water velocities, resulting in fewer suspended solids and dissolved chemicals being carried by runoff water to watercourses. Crops and crop residue allow water to infiltrate the soil more rapidly than bare soil, as well as reduce runoff and erosion. An added benefit is that water entering the soil is filtered by the soil and plant roots take up nutrients.

**Wildlife Habitat**

Crops can provide wildlife with feed and habitat. Some crops may be specifically planted as ‘lure’ or ‘sacrifice’ vegetation for migrating birds. In addition, shelterbelts or windbreaks may provide soil and water conservation benefits as well habitat for beneficial birds or insects. Riparian plantings offer such benefits in addition to enhancing fish habitat and improving water quality.

⇒ see Riparian Areas, page 11-13
OUTDOOR CROPS

This section discusses outdoor crop practices common to these crops:

- berries
- bulbs
- Christmas trees
- fiber
- field grown flowers and nursery stock
- field vegetables
- forage seeds
- forages
- ginseng
- grains and oilseeds
- grapes
- medicinal and herb
- nuts
- pastures
- tree fruits
- sod
- other specialty crops

See Indoor Crops and Container Nurseries, page 4-12, for outdoor container nurseries

OUTDOOR CROP ENVIRONMENTAL CONCERNS

Primary environmental concerns related to outdoor crop management are:

- harvesting annual crops that leave the soil bare for extended periods and results in soil erosion
- harvesting of crops that results in excessive soil removal
- under production and poor crop uniformity (yield and quality potential not being realized due to weeds, diseases, poor water management, drought, low plant density, etc.) that results in unutilized nutrients causing water pollution, or results in soil erosion causing air or water pollution
- leachate from stored crops (e.g., silage) that results in water pollution
- crop processing dust or crop residue burning that results in air pollution
- movement of invasive plants, exotic pests or infected plant material that results in biodiversity impacts and/or threats to other crops
- conversion of land to agricultural production (e.g., drainage of wetlands) that results in loss of critical habitat and release of greenhouse gas to the atmosphere

For detailed information on these concerns:

- see Impacts on Biodiversity and Habitat, page 7-8, and refer to Farm Activities and Impacts
- see Soil Quality Factors, page 8-2, refer to Compaction
- see Soil Loss by Harvest, page 8-14
- see Water Quality and Quantity Factors, page 9-2, refer to Contaminants
- see Air Quality Factors, page 10-1, refer to Dust and Particulates, to Odours, and to Open Burning
- see Farm Activities and Impacts, page 12-6, and refer to Land Clearing
OUTDOOR CROP LEGISLATION

The following is a brief outline of the main legislation that applies to outdoor crops.

- see page A-1 for a summary of these and other Acts and Regulations

Agricultural Land Commission Act

This Act requires agricultural land within the Agricultural Land Reserve not be used for non-farm use unless permitted by the Act. The removal of soil and placement of fill are deemed to be non-farm uses except as provided in Agricultural Land Reserve Use, Subdivision and Procedures Regulation.

- Section 4(1): allows for the removal of soil or placement of fill when operating a turf farm as long as the necessary notification requirements in the Regulation have been met

Drinking Water Protection Act

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).

- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system

Environmental Management Act

The Code under the Agricultural Waste Control Regulation has specific requirements regarding agricultural wastes:

- Section 3: agricultural vegetation wastes must be collected, stored, handled, used and disposed of in a manner that prevents pollution
- Section 12: agricultural vegetation waste must be applied to land as a fertilizer or soil conditioner
- Section 30: agricultural products must be managed, used and stored in a manner that prevents the escape of agricultural waste that causes pollution

Plant Protection Act

Regulations under this Act provide for the prevention of the spread of designated pests (e.g., insect, plant or disease) destructive to specific plants.

This Act prohibits activities that may cause a health hazard:

- Section 15: a person must not willingly cause a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard

Public Health Act

The Act also has conditions under the Public Health Act Transitional Regulation:

- Section 18: separation distance from wells to be at least 30.5 m from any probable source of contamination (probable source of contamination could include leachate from stored crops)

Weed Control Act

This Act imposes a duty on all land occupiers to control designated noxious plants.

Wildlife Act

The provincial Wildlife Act protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under
permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

**Fisheries Act**
This Act has three sections of importance to outdoor crop management:
- Section 35: prohibits harmful alteration, disruption or destruction of fish habitat unless authorized
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substance could include eroded soil)
- Section 38(4): requires reporting infractions of Sections 35 or 36

**Plant Protection Act**
This Act protects plant life by preventing the importation, exportation and transportation of pests.

**Species at Risk Act**
This Act has sections that protect listed species, their residence and critical habitat. It applies to federal lands, internal waters (i.e., all watercourses), territorial seas of Canada, and the air space above them.

The provisions of the Species at Risk Act (known as the ‘safety net’) could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

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**OUTDOOR CROP BENEFICIAL MANAGEMENT PRACTICES**

Comply with applicable outdoor crop related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

**Outdoor Crop Soil Management**
Improper crop management practices can cause soil degradation. Bare soils are prone to erosion and compacted soils will contribute to reduced crop yield and quality. Both conditions carry a greater risk of runoff flows transporting sediments into watercourses. Follow the same beneficial management practices outlined under protecting soil quality when cultivating for crop production.

see Chapter 8, Soil

**Cover Crops**
Cover cropping and relay cropping are practices that can aid in the management of pests, weeds, nutrients and soil tilth, while benefiting wildlife and providing additional forage yield. Implement the following practices:
- plant annual cover crops following crop harvest (e.g., oats after carrots)
- plant annual cover crops to fill gaps between perennial crop rows (e.g., barley between raspberry rows)
- plant perennial cover crops to fill gaps between perennial crop rows (e.g., grasses between orchard rows)
- if fall manure application is planned, plant cover crops early enough to ensure that sufficient growth has occurred to utilize nutrients (emergence by mid September is typically necessary)

**Relay Crops.** Relay cropping is a form of cover cropping used by forage producers (e.g., the use of Italian ryegrass between the rows of silage corn). Relay cropping is practiced to reduce weed growth during the growing season, to provide an active crop available for fall manure application after corn is
harvested, to protect soil from erosion, and to provide additional forage yield. Implement the following practice:

- plant a relay crop instead of a fall-planted cover crop if fall manure application is planned to ensure better nutrient uptake

**Catch Crops.** Catch crops are a specific type of cover crop. The primary goal of a catch crop is to utilize nutrients that would otherwise be leached from bare soil during the fall and winter. In spring, catch crop nutrients can be removed from the field as a livestock feed or recycled by cultivation into the soil for use by a subsequent crop. Implement the following practices:

- following crop harvest, test the soil for residual nutrient levels to determine the need for a catch crop
- plant a catch crop if there are unused nutrients in the soil

**Plowdown of Cover Crops.** When cover crops are plowed down, the decomposition of plants, shoots and roots releases a flush of nutrients, particularly nitrogen, into the soil. In high precipitation areas, spring is the preferred season for plowdown to reduce the risk of nitrogen leaching to watercourses or ground water.

**Strip Cropping**

On long sloping fields, crops grown in strips on the contour will minimize the effects of concentrated water flow. This will encourage water to infiltrate into the ground, reducing soil erosion.

**Crop Rotation**

Crop rotation refers to the practice of growing two or more crops with different growth habits on a given field during different time periods. For example, in the dairy industry a perennial grass or grass-legume mix can be grown for a period of time after which the crop is plowed down with an annual silage corn crop replacing it. The two crops have different rooting characteristics, and varying nutrient and cultivation requirements. Crop rotation crops can provide an environmental benefit by improving soil structure and nutrient management by reducing erosion and by allowing greater flexibility in the management of pests.

- practice crop rotation in order to ensure efficient nutrient use, to aid in maintaining soil tilth, and to provide good pest management

**Buffers**

Establish and maintain an adequate vegetative buffer between outdoor crop activities and sensitive areas to avoid noise, dust, and odours from causing a nuisance or pollution. see Buffers, page 11-4

**Outdoor Crop Nutrient Management**

The management of nutrients for crops is necessary to achieve a desired yield and uniformity.

Nutrient requirements for every crop will be different. Forage grasses, for example, are greater nitrogen users than silage corn. It is important to know the nutrient requirements of a given crop to prevent the waste of nutrients and to prevent pollution from excessive application. Nutrients that are not utilized by the crop have the potential to be leached into groundwater and/or transported by surface runoff.

Nutrient management refers to the balancing of nutrients removed by a crop during growth with the nutrients available to it from all sources in a manner that protects the environment. see Chapter 6, Soil Amendments
Planting Date. Planting dates will impact nutrient uptake. While crops are usually planted when climate, soil or market conditions are suitable, nutrients only become available in response to specific weather, soil conditions and to human activity. As a result, planting and growth do not always mirror optimum nutrient availability.

♦ choose crop variety and planting dates appropriate to the weather and soil conditions of the site to optimize nutrient availability

Outdoor Crop Water Management

Water management is critical to most crops. A high water table or drought conditions will reduce the yield of a crop, resulting in reduced utilization of applied nutrients. Where possible, manage water for optimum growing conditions.

⇒ see Irrigation, page 9-18
⇒ see Drainage, page 9-36

Invasive Pest Management

Invasive pests include insects, plant diseases, and weeds. Transfer is common in areas where farm equipment and farm products move back and forth between fields and farms. Bacteria, fungi or other organisms growing on the crop or in the soil are readily picked up by equipment. Plant disease and weed infestations can result in significant losses in crop quality and/or yield. Severe contamination may even reduce the range of crops that can be grown on a site.

⇒ see Chapter 11, Biodiversity

To ensure that pests, diseases and weeds are not spread, implement the following practices:

♦ purchase certified plant material or seed, and visually inspect plant material for pests upon receipt and prior to planting
♦ when using equipment in fields with known disease or weed problems, thoroughly disinfect equipment before moving out of the field
⇒ see Chapter 5, Pest Management

Outdoor Crop Management

Annual Crops. Production and harvesting of annual crops (e.g. carrots, sweet corn) can result in soil erosion when soil is left bare over winter. Harvesting of certain crops can result in significant soil loss. Crop residues from annual crops can generate leachate if they come in contact with water, resulting in a risk of pollution. ⇒ see Soil Loss by Harvest, page 8-14

Cranberries. Water management for cranberries differs markedly from that of other berries and crops due to the variety of ways that water is used in cranberry production. Water is used for irrigation, disease and insect control, frost protection, and harvesting. Growers impound water near cranberry beds to address the crops’ extensive water requirements.

The extensive use of water in cranberry production creates the potential to place fertilizers, pesticides, and other chemicals (such as woodwaste leachate) in solution or suspension and to carry them into adjacent waterways. Implement the following practices to prevent water pollution:

♦ recover and recycle flood water used in cranberry production
♦ after application of a pesticide, impound the effected runoff within the boundaries of the farm for the period of time specified on the pesticide label
  • when discharging water
  • screen debris from water used for harvesting prior to discharge
• if unsure about discharge water quality, test it prior to discharge to meet the water quality objectives of the watercourse

http://www.env.gov.bc.ca/wat/wq/

• if the water quality is acceptable, release it from impoundment areas gradually to avoid excessive rise in the water table and/or flooding of downstream neighbours

• if the water quality is unacceptable, obtain authorization from MOE before discharge

Forage Areas Used by Livestock. Implement the following crop practices for fields that are grazed or used as livestock overwintering sites:

♦ leave sufficient plant cover to protect the soil from compaction and erosion

♦ this may require increased crop residue to be left in the fall on affected areas or reduced stocking rates to prevent excessive trampling

♦ account for the nutrient content of manure deposited by livestock to match the affected area’s need for fertilizer

→ see Outdoor Livestock Areas, page 3-7

→ see Nutrient Application, page 6-8

Forage Grass. Potassium levels in forage grass grown on dairy farms have been increasing to cautionary levels in recent years. Potassium is the only major nutrient associated with the concept of ‘luxury consumption’. Luxury consumption of potassium is strongly associated with the intensive production of grass forages and refers to the uptake of a nutrient well in excess of a plant’s requirement for growth. Grass tetany may result from cows eating grass grown on high potassium soils.

Nitrate-nitrogen can, if the concentration in soil is high enough or if there are rapid changes in moisture or temperature, accumulate in plant tissue and cause nitrate toxicity to livestock.

Soil and forage testing are essential to monitor both potassium and nitrate levels on intensive operations. Potassium leaches very slowly with the result that it may build up in soils if application exceeds crop needs.

→ see Nutrient Management Planning, page 6-11

Forage Plowdown. When perennial forage stands are plowed down, the decomposition of plants, shoots and roots releases a flush of nutrients, particularly nitrogen, into the soil. In high precipitation areas, spring is the preferred season for plowdown to reduce the risk of nitrogen leaching to watercourses or ground water.

Medicinal and Herb Crops. Do not cultivate invasive plants as a crop.

www.agf.gov.bc.ca/cropprot/nonnativepests.htm

http://www.invasiveplantcouncilbc.ca/

Nursery Stock - Field Grown. Implement the following practices to minimize soil loss:

♦ when planting container nursery stock into a field use the largest feasible pot size to reduce the amount of native soil lost during harvest
♦ practice root pruning for all ball and burlap plant material to minimize root ball size – keep root balls to industry standards to preserve soil
♦ after nursery crop harvest, rest the soil with a seeded cover crop for one year
   • work cover crop into the soil after it has grown to trap nutrients and provide more organic matter to the soil
♦ replace soil removed in the root ball by the addition of soil amendments such as compost ➔ see Chapter 6, Soil Amendments

BC Landscape Standard 2008

Sod. Implement the following practices to minimize soil loss:
♦ reduce harvest to once every 15 months (suggested)
♦ optimal harvest sod soil thickness is 1 cm (suggested)
♦ use netting material to reduce the volume of soil harvested
♦ apply organic and/or mineral material to the soil between harvests

Tree Fruit and Berry. If burning of prunings is practiced, follow the open burning regulations. ➔ see Open Burning, page 10-17

Crop Residue Crop residue that is not managed properly can be an environmental concern. Implement the following practices for crop residue:
incorporate residue into the soil that is easily moved or transported by wind or water (e.g., can be washed or blown to watercourses)
leachate from residue piles must be managed to prevent water pollution ➔ see Leachate, page 9-48

Forage Seed Production. If burning of stubble is practiced, follow the open burning regulations. ➔ see Open Burning, page 10-17

New Crop Development When developing new cropland, protect critical fish and wildlife habitat. ➔ see Wildlife and Wildlife Habitat Protection, page 7-21 ➔ see Riparian Areas, page 11-13

Stewardship Crops There are many crop and non-crop plantings that exist for land and/or stewardship purposes, including:
♦ lure or sacrifice crops grown to draw wildlife away from feeding on forage cash crops
♦ field margins and hedgerows dedicated to wildlife use or providing refuge for wildlife and domestic livestock during harvesting or inclement weather
♦ grass fields normally used for annual cropping but which have been set aside for the sole purpose of providing a benefit to soil biota and to enhance soil structure and fertility

Roadsides, field corners and riparian areas can also be planted with stewardship crops. Such areas can be managed for limited harvest as well as to provide cover for wildlife. Stewardship crops are increasingly being placed as buffers for overland water flow to capture nutrients and sediments. ➔ see Chapter 7 Stewardship Areas, page 11-1
Crop Handling
Harvested crops may be lost (spilled) in the field, during handling to and from storage, and while in storage. To prevent surface water or ground water contamination, implement the following practices:
- keep crops contained during transport to eliminate losses
- clean up spills before water sources are negatively impacted
- remove waste feed promptly to reduce odours and rodent activity

Crop Processing
For concerns related to disposal of crop wash water, crop drying (e.g., grain) and feed mills ➔ see On-Farm Processing and Sales, page 2-42

Livestock Feed. Contain raw materials and processed feeds. Uncontained feed has the potential to contaminate surface water or ground water. Select a site with good drainage, preferably elevated and easily accessible. Divert roof water and clean runoff away from the site. Clean up spilled feed as soon as possible to reduce odour, discourage rodent activity, and to prevent contamination of surface water. Collect, store and handle feed-contaminated surface water. ➔ see Runoff, page 9-42, ➔ see Leachate, page 9-48

Install dust collection or suppression equipment to prevent the dispersion of feed dusts. Establish and maintain an adequate buffer between feed processing areas and neighbours to mitigate noise and dust from causing nuisance or pollution. ➔ see Buffers, page 11-4, ➔ see Dust and Particulate, page 10-10

Crop Waste Disposal
Manage culled or spoiled unusable crops as soil amendments. ➔ see Chapter 6 for use of crop wastes as soil amendments. Water that contains crop waste must be handled as contaminated water. ➔ see Collecting, Storage and Use of Contaminated Water, page 9-44

Crop Storage
Crops must be stored properly to prevent contamination of water sources. Most contamination under forage and vegetable storage conditions is caused by nutrient rich leachate leaving crop material or water contacting the stored crop, creating leachate. Store crops on hard surfaces to more easily divert and contain leachate and cover to avoid precipitation contacting the stored crop. ➔ see Buildings and Roads, page 2-2, ➔ see Runoff, page 9-42 ➔ see Leachate, page 9-48

Forage Crop Storage
The following comments on feed storages are separated based on whether such storages are located in high or low precipitation climates. High precipitation exceeds 600 mm total winter precipitation; low precipitation is less than 600 mm. ➔ see Appendix B.1, page B-2

Hay Storage: Low Precipitation. Implement the following practices:
- choose a well-drained site not subject to seasonal water flow or flooding
- lay out the site for convenient cleanup of spillage
- divert clean runoff away from the site ➔ see Runoff, page 9-42
- ensure any contaminated runoff leaving the site is controlled and collected
- consider covering hay with a tarp or structure to prevent leachate formation
- use gravel splash pads at the base of hay shed walls for roof stormwater erosion control
Hay Storage: High Precipitation. Implement the following practices in addition to those listed above for low precipitation areas:
- cover hay storages to reduce feed losses and to eliminate leachate
- use eavestroughs, downpipes and drain piping for roof stormwater control

Silage Storage: Low Precipitation. Silage leachate poses a great pollution concern. If silage leachate is produced, contain it to prevent entry into watercourses. In low precipitation areas, open pit storages are suitable. Implement the following practices:
- locate silage storage away from yard drain inlets, ditches and wells and 15 m or more from watercourses (suggested)
- choose a well-drained site not subject to seasonal water flow or flooding
- divert clean runoff away from the site
- since silage leachate is expected to be generated, have an impervious floor (e.g., concrete or other material) to contain the leachate
- construct silo floors to drain towards the open end to avoid the pooling of rainwater and silage leachate within the silo storage area itself
  - divert any potentially contaminated flows away from watercourses
  - direct contaminated flows onto adjacent fields to soak in if pollution will not occur or divert to a liquid storage facility such as a manure pit

Store silage in plastic bags on sites similar to those above with the following additional practices in place to prevent leachate escape:
- prepare the site base with fine compacted gravel, concrete, or asphalt to prevent bag puncture
- fence to deter livestock and wildlife in order to prevent bags from tearing
- keep free of ruts and weeds to discourage rodents
- where required, bait the site to control rodents

Silage bag handling can result in a large amount of waste plastic material which must be disposed of correctly. ➔ see Farm Refuse Disposal, page 2-15

Silage Storage: High Precipitation. Implement the following practices in addition to those listed above for low precipitation areas:
- cover storages to reduce silage leachate
- use eavestroughs, downpipes and drain piping for roof stormwater control
Indoor and Container Nursery Crops

This section discusses indoor crop practices common to these crops:
- button & specialty mushrooms
- container-grown nursery stock
- greenhouse-grown crops

Indoor and Container Nursery Crops Environmental Concerns

Primary environmental concerns related to indoor crops and container nursery production are:
- escape of leachate or spent nutrient solution from the production facility that results in nutrients causing water pollution
- increased water flow leaving the site due to the amount of impervious surface that results in soil and watercourse erosion and downstream flooding
- emissions from greenhouse boilers that result in air pollution
- inappropriate crop residue management that results in soil, water and air pollution
- movement of plant material infested with invasive plants or exotic pests or the invasive plants or exotic pests themselves that results in impacts to biodiversity
- mushroom media production that results in water or air pollution

For detailed information on these concerns:
- see Heat Production and Agricultural Boilers, 2-39
- see Impacts on Biodiversity and Habitat, page 7-8, and refer to Farm Activities and Impacts
- see Soil Quality Factors, page 8-2, refer to Contaminants
- see Water Quality and Quantity Factors, page 9-2, refer to Contaminants, and to Overland Flow
- see Air Quality Factors, page 10-1, refer to Contaminants, to Dust and Particulates, and to Odours

Indoor and Container Nursery Crops Legislation

The following is a brief outline of the main legislation that applies to indoor crops and container nurseries.
- see page A-1 for a summary of these and other Acts and Regulations

Local Bylaws

Many local governments have specific bylaws on mushroom media production, greenhouse coverage, heating fuel (emissions) and lighting.
Agricultural Land Commission Act

This Act requires agricultural land within the Agricultural Land Reserve not be used for non-farm use unless permitted by the Act or its regulations. The removal of soil and placement of fill are deemed to be non-farm uses except as provided in Agricultural Land Reserve Use, Subdivision and Procedures Regulation.

- Section 2(4): allows for the removal of soil or placement of fill necessary for a specific use as long as it does not:
  - cause danger on or to adjacent land, structures or rights of way
  - foul, obstruct or impede the flow of any waterway
- Section 4(1): allows for the removal of soil or placement of fill when constructing and operating a greenhouse or mushroom production facility that covers more than 2% of the area of the parcel as long as the necessary notification requirements in the Regulation have been met

Environmental Management Act

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).

- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system

There are two regulations under the act that pertain generally to crops and specifically to mushroom media production.

The Code under the Agricultural Waste Control Regulation:

- Section 3: agricultural wastes must be collected, stored, handled, used and disposed of in accordance with all other provisions of the Code and in a manner that prevents pollution
- Section 16: composting of agricultural waste for the production of mushroom media on a farm is allowed if:
  - the mushroom media produced is used only on that farm
  - the composting site is located at least 15 m from any watercourse and at least 30 m from any source of water for domestic purposes
  - the compost is prepared in a manner that does not cause pollution
- Section 30: agricultural products must be managed, used and stored in a manner that prevents the escape of agricultural waste that causes pollution

Mushroom Composting Pollution Prevention Regulation applies when a farm is producing media that will be sold off-farm. It regulates air and water discharges by requiring an implemented pollution prevention plan. The specifications for the plan are identified in the Regulation.

Plant Protection Act

Regulations under this Act provide for the prevention of the spread of designated pests (e.g., insect, plant or disease) destructive to specific plants.

Public Health Act

This Act has conditions under the Public Health Act Transitional Regulation:

- Section 18: provides separation distance of wells to be at least 30.5 m from any probable source of contamination (probable source of contamination could include leachate from mushroom media, crop residues and woodwaste)
**Weed Control Act**  This Act imposes a duty on all land occupiers to control designated noxious plants.

**Fisheries Act**  This Act has four sections of importance to indoor and container nursery crop production:
- Section 35: prohibits harmful alteration, disruption or destruction of fish habitat unless authorized
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include leachate from mushroom media, crop residues and woodwaste)
- Section 37: requires approval for any work that may impact fish
- Section 38(4): requires reporting infractions of Sections 35 or 36

**Plant Protection Act**  This Act protects plant life by preventing the importation, exportation and transportation of pests.

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## INDOOR AND CONTAINER NURSERY CROPS BENEFICIAL MANAGEMENT PRACTICES

Comply with applicable legislation, including the above, and where appropriate, use the following beneficial management practices to protect the environment.

**Indoor Crops and Container Nursery Facilities**  Implement the following practices for indoor crops and container nursery facilities:
- locate with proper setbacks from watercourses  ➔ see Farm Building Siting, page 2-4
- locate where contaminated runoff or leachate can be controlled and collected
  - fine textured soils (soils with more than 20% clay content) are preferred as leachate does not move as quickly through clays and remain on the surface allowing them to be collected
- collect and manage roof water if roof area is more than 10% of a site area (suggested)
  - stormwater flow is increased as impervious roofing or yard areas are increased ➔ see Buildings and Roads Practices, page 2-9
- establish and maintain an adequate buffer between greenhouse, container nursery and mushroom facilities and neighbours to avoid noise, dust, and odours from causing a nuisance or pollution ➔ see Buffers, page 11-4

**Nutrients Applied Through an Irrigation System (Fertigation)**  When nutrients are applied through an irrigation system, implement the following practices:
- install an efficient and uniform application system
- match application rates and amounts to crop requirements to reduce over watering and excessive leaching (e.g., a computerized irrigation scheduler controlling a drip system is more efficient than an overhead system)
- for container crops, use drip irrigation when practical to apply water to the crop
  - avoid areas where crops are not grown to eliminate the need to capture any nutrient-rich water
Leachate. The degree of leaching required to maintain healthy container crops is strongly related to the tolerance such crops exhibit to accumulations of salts within the growing media. Manage salt levels in growing media to minimize the need for leaching and the subsequent discharge of nutrient-rich water. Leachate may account for 10% to 30% of total irrigation water applied. If leachate has nutrient or pesticide levels that could cause pollution the water must be captured and recirculated or retained until such time that it can be discharged without causing pollution.  see Leachate, page 9-48

Implement the following practices to manage leachate:
♦ for impervious subsoil, recover irrigation waste water in field drains for storage
♦ for pervious subsoil, use concrete floors or polyethylene floor liners in greenhouses or nurseries to collect all leachate
♦ in greenhouse or nursery production, use water recirculation techniques to both reuse leachate as a nutrient source and to conserve water
  • due to disease transfer concerns, recirculation is not feasible on all operations

Spent Nutrient Solution. The concentration of nutrients in recirculated water can be reduced by decreasing the amount of fertilizer added at the end of a production cycle. Dispose of the spent nutrient solution at the end of the cycle by applying to other suitable agricultural crops.  see Nutrient Application, page 6-8

Any effluent discharge into the environment, which is not being used as a fertilizer for crop production, requires a permit from MOE.

Invasive Pests
To ensure that neither diseases nor pests are spread, implement the following practices when purchasing propagative plant material:
♦ do not propagate invasive plants
♦ use certified pest-free plant material if available
  • monitor plants upon arrival to the farm
  • if possible, isolate new plant material for a period of time prior to moving into production areas  see Chapter 5, Pest Management

Soilless Media Storage of Media. Store raw materials as well as prepared and spent media in such a way as to prevent their release into the environment.

Use of Media. The choice of growing media in a greenhouse or nursery operation has a significant effect on overall water consumption. Watering efficiency can be increased through the choice of substrates with higher water holding capacity. However, such substrate use may be limited by an often higher potential for root rot.

Disposal of Media. Dispose of unused, spent or waste media in a manner that does not cause pollution. Reuse within the operation or use these materials as a soil conditioner.  see Soil Conditioner Application page 6-29
Greenhouse Roof. Shade materials such as nettings or curtains are preferred over shading compounds that are sprayed on greenhouse roof or walls. Shading compounds used on the outside of greenhouse structures can contribute to stormwater contamination. Capture and appropriately deal with contaminated water that will cause pollution. ➔ see Runoff, page 9-42

Consider using rainwater collected from greenhouse roof systems as an alternative source of irrigation water.

Crop Residue. Other parts of this Guide address concerns associated with crop residue from greenhouses:
- prunings, plants and waste organic media application to soil ➔ see Soil Conditioner Application, page 6-29
- organic wastes for compost ➔ see Compost, page 2-32
- plastic clips, strings, pots, rockwool ➔ see Farm Waste, page 2-13

Building Drains. Greenhouses may be constructed with perimeter drains to divert clean roof water away from the roof and building foundation. If a greenhouse also has separate drains to collect spent irrigation water or contaminated floor water, implement the following practice:
- test drains to ensure they are not cross-connected by introducing a MOE-approved dye into the contaminated water drain system and checking that the dye does not show up in the perimeter drain discharge

Boiler Emissions. Greenhouse boilers may generate air emissions that contribute to climate change or particulates that could result in air pollution. ➔ see Heat Production and Agricultural Boilers, page 2-39

Light Emissions. Greenhouses may emit light that causes a nuisance to neighbours. Depending on the intensity of your lights and the light emission reduction desired, consider using the following:
- do not use supplemental lighting during the evening hours of 6 PM to midnight. (crops need a period of darkness; this will minimize impacts on your neighbours)
- control overhead light emissions (if crops will allow)
  - use light abatement material such as black-out curtains, light abatement screens or thermal curtains on side walls
- consider vegetation buffers for very close neighbours (an IPM program may be required to reduce potential insect problems resulting from the buffer)

Nursery Woodwaste. The use of woodwaste products such as sawdust and hog fuel is regulated under the Environmental Management Act as leachate from this material can be toxic to fish. ➔ see Woodwaste, page 2-27

Crop Residue. Other parts of this Guide address concerns associated with crop residue from nurseries:
- prunings, plants and waste organic media application to soil ➔ see Soil Conditioner Application, page 6-29
- organic wastes for compost ➔ see Compost, page 2-32
- sheet plastic, pots, trays, fertilizer bags, pesticide containers ➔ see Farm Waste, page 2-13
Mushroom Media Production. Beneficial practices specific to mushroom media production include those associated with both the storage of raw materials and with composting.

Organic materials, if not handled carefully, may create leachate, runoff and odour problems while undergoing decomposition in storage. Odour is a particular problem with wet straw-bedded horse manure or poultry litter. In addition, if raw materials are exposed to high rainfall, the runoff will be contaminated with organic compounds. Store all raw materials in a manner that prevents the escape of agricultural wastes that may cause pollution. Cover all manure-based raw materials to avoid runoff and odour problems. Locate media production sites to meet the Public Health Act and Agricultural Waste Control Regulation requirements.

The potential for leaching from compost piles is significant. Carry out all composting on a hard, impermeable surface designed to collect leachate. Use covered compost facilities in areas receiving high rainfall.

Compost Production Odour Reduction. Mushroom compost production produces odours and careful attention to site selection will help to minimize nuisance odour problems. Install scrubbers and biofilters to reduce odours on sites located close to neighbours.

- see Composting, page 2-32
- see Protection of Air Quality, page 3-4, and refer to Biofilters

Fresh Media Storage. Mushroom media is typically stored on a concrete pad near the mushroom house while the beds are filled. During this time, the compost may be exposed to rain, creating leachate and contaminated runoff.

Implement the following practices:
- locate media storage (fresh and spent) away from yard drain inlets, ditches, wells and watercourses
  - at least 30.5 m from wells (Public Health Act)
  - 15 m or more from watercourses (suggested)
  - 30 m or more from water intake used for domestic purposes (suggested)
- minimize the amount of runoff
  - schedule compost deliveries to arrive as the compost is required
  - fill beds as soon as possible after the compost arrives, keeping it out of the rain
  - provide a covered storage area for fresh media in high precipitation areas such as the Lower Fraser Valley and Vancouver Island
  - clean up debris from receiving and filling areas frequently
  - divert runoff away from fresh media piles
  - collect all contaminated runoff that can pose a pollution risk
- see Runoff, page 9-42
Spent Media. Once mushrooms have been harvested, the compost is considered "spent media" and removed from the barn. Construct berms or other containment works to divert clean runoff away from spent media piles and to prevent any leachate or contaminated water flows from entering surface or ground water. Collect, store and treat or apply to the land any runoff that has contacted spent media. Spent media can be applied to soil as a soil conditioner.  

§ see Runoff, page 9-42  
§ see Soil Conditioner Application, page 6-29

Building Drains. Mushroom barns may be constructed with perimeter drains to divert clean roof water away from the roof and building foundation. If a mushroom barn also has separate drains to collect contaminated water, implement the following practice:

♦ test drains to ensure they are not cross-connected by introducing a MOE-approved dye into the contaminated water drain system and checking that the dye does not show up in the perimeter drain discharge

Crop Waste Disposal Manage culled or spoiled unusable crops as soil amendments.  

§ see Chapter 6 for use of soil amendments. Water that contains crop waste must be handled as contaminated water.  
§ see Collecting, Storage and Use of Contaminated Water, page 9-44
## Metric Conversions

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Conversions in this table are rounded to a convenient number. See Appendix E for exact conversion factor.

Values from tables and examples are not included in Metric Conversions.
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5 PEST MANAGEMENT

INTRODUCTION

This chapter describes how Integrated Pest Management practices contribute to reduce the impact of managing agricultural pests on the environment. It contains introductory information on the relationship between pest management and the environment. It also contains information on environmental concerns, legislation and beneficial management practices related to:

♦ pest management
♦ pesticides

PEST MANAGEMENT AND THE ENVIRONMENT

Pests are a constant threat to the economical production of food crops and animals. They may also affect food safety and reduce natural biodiversity. The proper implementation of Integrated Pest Management (IPM) practices helps to protect the environment from the potential adverse effects of pests and pest management.

Integrated Pest Management (IPM)

Integrated Pest Management is a decision-making process for pest control. The process contributes to effective, economical and environmentally sound suppression of pests for crop and livestock production. IPM incorporates several methods to achieve pest control (e.g., crop rotation, crop variety selection, soil amendments, pesticides, time of planting and harvest, etc.).

Noxious Weeds

Noxious weeds are typically non-native plants that have been introduced to British Columbia without the insect predators and plant pathogens that normally keep them in check in their native habitats. For this reason and because of their aggressive growth, these alien plants can be highly destructive, competitive, and difficult to control. Noxious weeds are among the top causes for loss of natural diversity in the environment.

Pesticides

Pesticides are any kind of chemical (organic or synthetic) used to kill, control, or manage pests. Fungicides, insecticides, miticides, herbicides, rodenticides and plant growth regulators are all types of pesticides. Pesticides are chemicals designed to protect crops and animals from pests and can pose risks to the environment. Pesticides are regulated to minimize known and potential risks through prescribed storage, handling, application and disposal practices.
Pests

Pests are organisms that cause undesirable effects to agricultural production and include fungi, bacteria, viruses, nematodes, insects, mites, weeds, slugs, rodents, birds and wildlife. They may occur naturally or be introduced from other areas.

Invasive Pests. Invasive pests not only pose a threat to crops and livestock, but also threaten native biodiversity by competing with local species for food and space. Many of the pests affecting cultivated and native plants in BC have been inadvertently introduced into the province. In the absence of natural controls, some have become established and have extended their range as the environment and as availability of host plants permits. Examples of invasive pests include gypsy moth, purple loosestrife, knapweed, canola blackleg, blueberry scorch virus and European chafer.
PEST MANAGEMENT ENVIRONMENTAL CONCERNS

Primary environmental concerns related to pests are:

♦ lack of control of pests that results in loss of biodiversity and natural beneficial organisms through invasive diseases, insects, and weed infestations
♦ improper choice of pest management strategies that results in soil erosion, water or air pollution, or impacts to non-target organisms

For environmental concerns related to use of pesticides to control pests.

➤ see Pesticides, page 5-11

For information on these concerns:

➤ see Impacts on Biodiversity and Habitat, page 7-7
➤ see Soil Quality Factors, page 8-2, and refer to Contaminants
➤ see Water Quality and Quantity Factors, page 9-2, and refer to Contaminants
➤ see Air Quality Factors, page 10-1, and refer to Contaminants

PEST MANAGEMENT LEGISLATION

The following is a brief outline of the main legislation that applies to pest management.

➤ see page A-1 for a summary of these and other Acts and Regulations

Local Bylaws

Many local governments have specific bylaws or restrictions on noise scaring devices for bird control. Some local governments have by-laws that require the control of specific pests. Local governments may also have by-laws restricting the use of “cosmetic” pesticides; these do not apply to agriculture.

Integrated Pest Management Act

This Act and the Integrated Pest Management Regulation have numerous requirements regarding the use, containment, transport, storage, disposal and sale of pesticides.

Plant Protection Act

Regulations under this Act provide for the prevention or spread of designated pests and diseases.

Weed Control Act

This Act requires all land occupiers to control designated noxious plants. The Weed Control Regulation designates noxious weeds, provincially and regionally.
**Wildlife Act**  
The provincial *Wildlife Act* protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

**Fisheries Act**  
This Act has three sections of importance to pest management:
- Section 35: prohibits harmful alteration, disruption or destruction of fish habitat unless authorized (e.g., removing stream side vegetation)
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include pesticides)
- Section 38(4): requires reporting infractions of Section 35

**Migratory Birds Convention Act**  
This Act protects most migratory birds in Canada.
- Section 5.1: prohibits the deposit of any substance that may be harmful to migratory birds in water or other areas that they frequent (harmful substances may be pesticides)

**Plant Protection Act**  
This Act protects plant life by preventing the importation, exportation and transportation of pests.

**Species at Risk Act**  
This Act has sections that protect listed species, their residence and critical habitat. It applies to federal lands, internal waters (i.e., all watercourses), territorial sea of Canada, and the air space above them.

The provisions of the Species at Risk Act (known as the ‘safety net’) could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

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**PEST BENEFICIAL MANAGEMENT PRACTICES**

Comply with applicable pest management related legislation, including the above, and where applicable, implement the following beneficial management practices to protect the environment.

**Integrated Pest Management (IPM)**

Integrated Pest Management is an approach that relies on the appropriate use of various sound practices to protect crops, animals, and the environment from the adverse impact of pests. Integrated Pest Management does not mean that chemical pesticides are never used nor does it require complete elimination of all pests. A properly designed program aims to create conditions that are optimal for crop production and less favourable for pest development.

Integrated Pest Management includes the use of production practices that prevent or reduce pest problems as well as use of monitoring to determine the need and correct timing of control methods, including pesticide applications. When used, IPM practices reduce potential impact to the environment by means of:
- less reliance on pesticides by effective use of non-chemical methods, including biological, cultural, behavioural, and mechanical control practices either alone or in combination with pesticides
♦ less risk of development of pesticide resistance that can lead to increased pesticide use and poor pest control
♦ encouraging use of least-toxic, target-specific pesticides as appropriate

Integrated Pest Management (IPM) is promoted and explained in the commodity-specific Crop Production Guides, shown below. They form a part of the Environmental Farm Plan series of Beneficial Management Practices. This detailed information is recommended for use by producers of these crops. Table 5.1, previous two pages, outlines the basic steps in an Integrated Pest Management. A complete list of Production Guides is available at http://www.agf.gov.bc.ca/cropprot/prodguide.htm

For more detailed information on Integrated Pest Management for specific crops, refer to the following publications.

- Berry Production Guide
- Best Practices Guide for Grapes for British Columbia Growers
- Field Crop Production Guide
- Floriculture Production Guide
- Fresh Market Grape Production - Best Practices Guide in British Columbia
- Ginseng Production Guide for Commercial Growers
- Growing Greenhouse Peppers in British Columbia: A production guide for commercial growers
- IPM for Turfgrass Managers
- Integrated Fruit Production Guide for Commercial Tree Fruit Growers
- Nursery & Landscape Pest Management Production Guide

Invasive Pests

It is important that any unusual or unfamiliar diseases, insects, or weed species be reported to AGRI or the Canadian Food Inspection Agency (CFIA) so that the species can be identified and so any necessary actions can be taken. Check the Weeds BC website, the AGRI publication Field Guide to Invasive Alien Plant Pests and Diseases that Threaten BC Agriculture and the non-native pests website for additional information on new and threatening invasive species.

➔ see Weeds, page 5-9, and ➔ see Chapter 7, Biodiversity
- www.agf.gov.bc.ca/cropprot/nonnativepests.htm
- www.weedsbc.ca

To reduce the possibility of introducing invasive pests to a farm, check with the Canadian Food Inspection Agency for permit requirements and other restrictions before importing plant material from outside B.C.
- www.inspection.gc.ca
### Table 5.1 Steps to Developing an Integrated Pest Management (IPM) Plan

#### 1. Plan & manage crop and animal production to avoid pest problems
- select a site that is environmentally suited to the crop, or select a crop or crop variety suited to the growing site to minimize predisposition of the crop to pest attack or competition
- optimize crop and animal health to avoid predisposition towards pest infestation
- encourage the establishment of available biological control agents that can keep pests from becoming problems
- use recommended crop and manure management practices to prevent or reduce the risk of attracting and establishing pests

**Example:** Brussels sprout variety ‘Vancouver’ is used in the Fraser Valley because of its suitability to that climate and its disease tolerance to pathogens significant to the area.

#### 2. Understand & Identify the pest

Develop a management strategy using information on how the pest, crop and environment affect one another. Determine:
- how to correctly identify the pest and the damage it causes to a crop
- the pest’s life cycle and its preferred food and environment requirements – most pests go through at least one developmental stage where control measures and products are most effective
  - different products may target a different life cycle stage
  - timing the use of control tools and actions to occur at the pests’ susceptible stage
- what conditions promote pest introduction, development and population increase
- how to identify any beneficial organisms that eat, compete with, or parasitize the pest

**Example:** Two fungal diseases of chrysanthemum must be properly identified because one (brown rust) causes minor damage and is not of regulatory significance and the other (white rust) is an invasive pest regulated by the Canadian Food Inspection Agency (CFIA). Improper identification or a delay in action will result in greater infestation and significant crop losses.

#### 3. Monitor populations of pests and beneficial organisms, pest damage & environmental conditions

Monitor the crop, flock or herd regularly to collect information on:
- the abundance and stage of development of pest populations
- the numbers of beneficial organisms present
- the crop stage and vigour
- the amount of crop damage
- temperature and moisture conditions - used in models to predict the occurrence of specific pest stages which can assist in decisions regarding the timing of pest management actions (few models are available at this time for BC)

**Example:** Using an apple scab forecasting model to determine when fungicides should be applied to protect apple orchards. The model uses leaf wetness and temperature data to predict the most likely period of infection.

#### 4. Use economic thresholds (where possible) and past experience in making pest control decisions

Ideally, pests are controlled in advance of reaching a level that causes unacceptable economic damage. However, such threshold data do not exist for the majority of pests. Take the following considerations into account when deciding if and when control actions are necessary:
- use pest numbers and life stage information from monitoring
  - the susceptibility of the crop to damage at various stages of growth
  - pesticide use restrictions such as pre-harvest interval, re-entry interval, buffer zone
- compare the pest control cost with the value of potential losses (quantity and/or quality) if the pest is not controlled (cost/benefit analysis)
  - economic thresholds are specific for given crop/pest combinations and can vary depending on local crop values and control costs
- consult with local experts or use past experiences to make control decisions

**Example:** Leaf rollers are counted in raspberry buds in spring and insecticide is used only if more than 10% of buds are affected (i.e., more than 10 leaf rollers per 100 buds).
5. Choose appropriate control methods

Use a combination of biological, cultural, mechanical, behavioural and chemical controls as described below.

**Biological Control:** beneficial organisms such as predators and parasites will help control pests. They are naturally occurring or can be released into an area to control pests when needed.

- predators eat the pest
- parasites and some predators live in or on the pest to weaken or kill it
- some microorganisms (i.e. bacteria, fungi, nematodes) reduce populations of plant pathogens or insect pests
- healthy soils often have high populations of “good” microorganisms
- commercially available beneficial microorganisms available (predators, parasites, nematodes, microbials are readily available)
- monitoring and encouraging beneficial organisms is an important part of an Integrated Pest Management program

**Example 1:** The controlled introduction of two moth species, (one feeds on roots and the other on leaves), and one flea beetle species, has provided successful control of the noxious weed Tansy Ragwort in localized areas on Vancouver Island and the Fraser Valley.

**Example 2:** Livestock grazing can help prevent weed seed production and gradually weaken the roots, reducing weed establishment and proliferation.

**Cultural Control:** production practices that discourage the introduction, establishment or development of pest populations, such as

- selection of varieties resistant to pests
- planting cover crops that compete with weeds and provide shelter or food for beneficial insects
- rotating of crop species to reduce pest population levels
- pruning to remove diseased material, thinning fruit or plants to create an environment less attractive or conducive to pests
- planting certified clean material
- reducing the accumulation of plant residues and animal waste where pests can breed
- timing of cultivation or soil disturbance

**Example:** Removal of waste material from confined livestock and poultry operations at least once every 10 to 12 days during the fly breeding season helps with fly control.

**Mechanical Control:** involves the use of barriers or devices to exclude or control pests. These include window screening, netting, rodent traps, seed cleaning to remove weed seeds, air curtains, fly paper, ground fabric, mulches

**Example:** Netting on blueberry farms to prevent bird damage on ripening fruit

**Behavioural Control:** takes advantage of specific attraction or repellent responses of pests to certain odours, sounds, and colours in order to cause confusion or disorientation and prevent mate or host finding

**Examples:** Insect mating disruption using sex attractants (pheromones), odour-baited traps, yellow sticky traps, distress recordings, repellents, and black light electrocutors for flies

**Chemical Control:** Can be considered when other preventive and non-chemical control options fail to keep pest levels sufficiently low. Pesticides can be used to prevent or reduce pest levels - pesticides vary greatly in risk posed to the environment, mode of action, chemical structure, target specificity, and toxicity (refer to Crop Production Guides)

- when possible, use least-toxic or reduced-risk pesticides such as insect growth regulators and biological pesticides derived from plants, bacteria or fungi
- pesticides labels are legal documents and it is the user’s responsibility to follow it. Using pesticides according to label directions will give best results and pose the least risk to the environment
- in order to prevent or delay the development of pesticide resistance, alternate pesticides from different chemical classes or groups. See front panel of label for type (e.g., fungicide) and the resistance management
- spot spray where possible

**Example:** Herbicides in pasture and rangeland, along with primary weed management strategies such as grazing and correct fertilizer applications can lead to good weed control.

6. Evaluate the effects & efficacy of the program

- keep good records such as: pest and weather monitoring, pesticide application (site or area treated, products and amounts used, crop stage, application dates, application methods, spray volume), crop harvest dates, crop yield and quality, and any other observations related to the condition or appearance of the crop or animals
- annually review this information to decide how to improve the Integrated Pest Management program
Pathogens  Pathogens (disease-causing organisms) are easily spread and diseases impact the host (plant or animal). Prevention is the best management strategy, but early detection and treatment can also be effective. While many pathogens are crop-specific, some may affect a wide range of crops. Implement the following practices:
- use clean certified seed or plant sources, where available
- remove infected plants or affected plant parts to prevent further spread
- practice crop rotation to discourage the build up of specific pathogens
- select disease-resistant varieties, where available
- use qualified laboratories to confirm pathogen identification and then follow their recommendations

Soil Fumigation. This technique is used to control soil borne pests such as nematodes. Implement the following practices:
- follow label restrictions
- ensure applicators have been certified and are using proper equipment
- do not apply when the weather forecast is for heavy rain
- ensure that adequate moisture is in the soil prior to fumigation
- use plastic tarps to seal in the fumigant to reduce air pollution and to increase effectiveness of treatment
- ensure that adequate buffers are in place to prevent soil loss from fumigated fields left bare through winter

Insects and Mites  Insects and mites are easily spread and can impact the host (plant or animal). The life cycles for many insect pests are well known and most management strategies target a specific developmental stage. Implement the following practices:
- remove insects to prevent their spread to other hosts
- practice crop rotation to discourage the build up of pests
- select insect-resistant or tolerant varieties of crops, where available
- monitor population levels of both pests and beneficial organisms
- learn to identify all species and development stages of pests and beneficial organisms
- protect and encourage the establishment of beneficial organisms
- when possible and appropriate, release (introduce) beneficial organisms

Flies in Confined Livestock Facilities. An integrated fly management program involves a combination of appropriate animal waste management and fly prevention measures. Implement the following practices:
- begin a fly control program early in the year
- maintain low fly populations by using
  - biological fly control programs
  - electronic zappers
  - chemicals such as fly cake and/or insecticidal bait bands or boards
Implement the following practices to reduce the need for pesticides to control nuisance fly populations:
- reduce or periodically remove fly breeding materials such as manure, bedding, and spoiled feed
- ensure that potential breeding materials are dried quickly and remain dry
• store manure in enclosed structures if it cannot be dried easily or if it
cannot be spread every 10-12 days
• dispose of dead animals using approved disposal methods
  ➔ see Livestock Mortality Disposal, page 3-37

In some situations, regular spraying with insecticides may be necessary for
effective fly control. Seek advice from a qualified pest control specialist before
embarking on any spraying programs. Ensure that only approved chemicals are
used. Spraying should never be considered a substitute for proper waste
management.

Management of Flies in Layer Barns
Control of Insect and Related Pests of Livestock and Poultry in British
Columbia

Weeds
Weeds reduce crop growth and affect the ability of crops to effectively use
nutrients. Although some weeds can use a significant amount of soil moisture
and nutrients, as they are not harvested, the nutrients remain in the field and will
be released when the weed material breaks down. To reduce the impact of
weeds, implement the following practices:
• always use clean certified seed
• control problem weeds before they go to seed
• practice crop rotation to discourage build up of specific weeds
• learn to identify weeds, particularly at the seedling stage
• apply appropriate controls at the recommended stage of crop and weed
development
• control persistent perennial weeds prior to planting crops
• use plastic and organic mulches to control or suppress weeds when
  appropriate
• prevent the movement of weeds to new locations via movement of
  livestock or equipment
  • discourage visits to the farm if the potential for weed movement exists
  ➔ see Invasive Pests, next page

Integrated Weed Management
Management in British Columbia
Rangeland Handbook for BC
A Guide to Weeds in British Columbia

Noxious Weeds. Noxious weeds should be prevented from becoming
established on a farm and, if present, prevented from spreading to neighbouring
properties by following the above beneficial management practices for weeds.
Noxious weeds are listed in the Weed Control Regulation.
Invasive Plant Alert: Prevent the Escape of Aggressive Plants
Field Guide to Noxious and Other Selected Weeds of British Columbia

Wildlife
Some wildlife, such as rodents and some birds, are managed as pests. Other
wildlife, such as deer, elk, or beaver, are managed as problem wildlife. For
problem wildlife information, ➔ see Biodiversity Conflicts, page 7-23
**Rodents**

To effectively ward off rodent infestations, implement the following practices:

- control food and water supplies by
  - avoiding spillage of feed both inside and outside barns
  - keeping all feed in covered containers
  - eliminating water sources like leaky taps, sweaty pipes and open drains
- rodent-proof buildings and eliminate nesting sites by
  - keeping buildings in good repair
  - keeping areas next to buildings free of weeds, long grass, and debris
  - screening ventilation ports and other openings
- maintain good general sanitation and cleanliness throughout the farmstead

When rats and mice are established, they can be controlled by poisoning with rodenticides, fumigating, trapping or any combination of such practices. Always place rodenticides in covered bait stations. If placed in and around manure piles, collect before the manure is removed for land spreading. Rodenticides spread on land with waste products pose a serious threat to pets, birds, farm animals, and wildlife. [Control of Rats and Mice on Poultry Farms]

**Birds**

Starlings, robins, crows, magpies and other bird species may cause significant crop loss, are a nuisance to livestock and crop producers, and have been implicated in the spread of diseases. Control measures are usually less effective once birds have established feeding patterns. Implement the following practices:

- bird-proof structures that store or contain grain
- clean up spilled grain immediately
- drain or fill water pools and puddles as starlings are attracted to water
- keep water in livestock waterers at levels low enough to prevent birds from drinking when perched on the waterer edge

To manage damage to crops, use techniques or equipment such as bird distress calls, noisemakers, netting, population control, and starling traps. Check local municipality bylaws before using any methods. Berry Production Guide

Bird Predation Management Plan - Blueberries

Starlings and Livestock Farms

Manage audible bird scaring devices according to Normal Farm Practices as set out in established standards and decisions issued by the BC Farm Industry Review Board.

www.firb.gov.bc.ca

Also refer to AGRI’s Wildlife Damage Control guidelines.

Wildlife Damage Control - Interior BC

Wildlife Damage Control - South Coastal BC
PESTICIDES

PESTICIDE ENVIRONMENTAL CONCERNS

Primary environmental concerns related to pesticides are:
- pesticides inappropriately applied, spray or vapour drift, spills, backflow and improper disposal of chemicals or containers that results in soil, water or air pollution; or in damage to non-target organisms
- birds and wildlife coming into contact with pesticides or crops receiving pesticide application that results in damage to birds and wildlife

For detailed information on these concerns:
- see Impacts on Biodiversity and Habitat, page 7-8, and refer to Impacts to Biodiversity and Habitat
- see Soil Quality Factors, page 8-2, and refer to Contaminants
- see Water Quality and Quantity Factors, page 9-2, and refer to Contaminants
- see Air Quality factors, page 10-1, and refer to Contaminants

PESTICIDE LEGISLATION

The following is a brief outline of the main legislation that applies to pesticides that are related to environmental protection.
- see page A-1 for a summary of these and other Acts and Regulations

Local Bylaws

The National Farm Building Code 1995 outlines standards for pesticide storage and is enforced only where proclaimed by local governments.
- Section 4.1.4: requires storage facilities for pesticides to:
  - be vented to the outdoors, accessible from outdoors only, secured against unauthorized entry
  - have an impervious floor that is curbed to contain spills,
  - be identified with a sign at entrance stating “Danger – Chemical Storage – Authorized Person Only” or words to that effect
  - be separated from all food, feed and water supplies
  - be insulated and have a heated cabinet for chemicals requiring frost protection
  - separate oxidizing and flammable chemicals

Local governments may also have by-laws restricting the use of “cosmetic” pesticides; these bylaws do not apply to land used for agriculture, residential areas of farms or for the management of pests that impact agriculture.
**Drinking Water Protection Act**

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).

- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system.

**Environmental Management Act**

This Act has two regulations dealing with pesticides.

The *Spill Reporting Regulation* requires spills of a polluting substance be reported immediately to the Provincial Emergency Program (PEP) at 1-800-663-3456 (24 hour service). Report spills of pesticides (pesticide, pesticide mixture or waste) greater than 5 kg or 5 litres.

The *Hazardous Waste Regulation* specifies empty pesticide containers will be considered hazardous waste unless rinsed and disposed of according to Table 5.3, page 5-23. Equipment wash water is also dealt with in Table 5.3.

**Integrated Pest Management Act**

This Act and the *Integrated Pest Management Regulation* have numerous requirements regarding the use, containment, transport, storage, disposal and sale of pesticides.

- Section 3 of the Act states that:
  - a person must not use a pesticide that causes or is likely to cause an unreasonable adverse effect
  - a person must not use, handle, release, transport, store, dispose or sell a pesticide in a manner that causes or is likely to cause an unreasonable adverse effect
  - a pesticide has to be used according to label instructions

The *Integrated Pest Management Regulation* has several sections that apply to agriculture:

- Section 1:
  - the definition for “body of water” allows pesticides to be applied according to label conditions to self contained human-made bodies of water (i.e. dugouts)
  - a permit or other authorization from MOE is required for any other application to water

- Section 5, 18, 24:
  - an authorization such as a pesticide use licence, pesticide use notice confirmation (pest management plan) or permit is required to apply pesticides to public land
  - the type of authorization required is dependent on the pesticide type, land use and area of land to be treated
  - contact the MOE regional office for details

- Section 16:
  - a valid pesticide applicator certificate issued by MOE is needed to purchase or use restricted or permit-restricted pesticides
information on pesticide applicator certification and examination is available at 1-800-282-7955 or (250) 356-0475 or [http://www.env.gov.bc.ca/epd/ipmp/pest_certification/certif_main.htm](http://www.env.gov.bc.ca/epd/ipmp/pest_certification/certif_main.htm)

Section 44:
- producers may only purchase pesticides from a licensed pesticide retailer
- anyone applying pesticides in exchange for a fee must have a valid applicator certificate and Pesticide Use Licence
- if a farmer sprays another’s crops they do not need a Pesticide Use License if the work is done as a favour and no money is exchanged

Section 65:
- pesticides must be kept in their original container with the original label
- if the label is not legible, the container must have the trade name of the pesticide, the name and concentration of active ingredient, and the registration number on it

Section 66:
- pesticides labelled Restricted or Commercial must be kept in locked storage that is vented to the outside and has a warning sign on the door that says “WARNING CHEMICAL STORAGE – AUTHORIZED PERSONS ONLY”
- pesticides must be stored separately from food intended for human or animal consumption

**Public Health Act**

This Act prohibits activities that may cause a health hazard:
- Section 11: requires the reporting of any health hazard to a prescribed person (a health hazard may be the escape of toxic substances)
- Section 15: a person must not willingly cause a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard

The Act also has conditions under the *Public Health Act Transitional Regulation*:
- Section 18: separation distance of wells to be at least 30.5 m from any probable source of contamination (probable source of contamination could include pesticides)

**Wildlife Act**

The provincial *Wildlife Act* protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

**Fisheries Act**

This Act has three sections of importance to pesticide management:
- Section 35: prohibits harmful alteration, disruption or destruction of fish habitat unless authorized (e.g., removing stream side vegetation)
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include pesticides)
- Section 38(4): requires reporting infractions of Section 35 or 36

**Migratory Birds Convention Act**

This Act prohibits the deposit of any substance harmful to migratory birds to any area frequented by migratory birds.
The Act and Pest Control Products Regulations require all pesticides used in Canada to be registered and have a Pest Control Products number on the label. Pesticides can only be used according to label directions (directions include environmental protection requirements).

Species at Risk Act
This Act has sections that protect listed species, their residence and critical habitat. It applies to federal lands, internal waters (i.e., all watercourses), territorial sea of Canada, and the air space above them.

The provisions of the Species at Risk Act (known as the ‘safety net’) could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

Transportation of Dangerous Goods Act
This Act regulates the handling and transportation of “poisonous substances” which includes pesticides. Farmers transporting more than 1,500 kg of pesticides in a licensed farm vehicle more than 100 km must comply with special requirements. Farmers moving a sprayer containing more than 6,000 litres of spray mixture for more than 100 km on a public road must comply with special requirements.

PESTICIDE BENEFICIAL MANAGEMENT PRACTICES
Comply with applicable pesticide related legislation, including the above, and where applicable, implement the following beneficial management practices to protect the environment.

Since pesticides are designed to harm target organisms, take proper safety precautions to protect non-target organisms and the environment. If pesticides come in contact with surface or ground water there is a high risk of environmental impact.

Pesticide Applicators Certificate
Pesticides that require a Pesticide Applicator Certificate before purchasing or use are listed in the various Crop Production Guides. see page 5-5

Pesticide Risks
Pesticide Movement. A pesticide is any material used to kill, control or manage pests, including products to manage the growth of plants. The primary concern related to pesticides is any unwanted movement to sensitive environmental areas such as watercourses, ground water, fish or wildlife habitat. Pesticides can move off-target by:

♦ drift – the movement of spray droplets or vapour in the air
♦ runoff – the movement across the surface of the land in water or bound to eroding soil
♦ leaching – the movement in water through the soil
♦ direct transport – the movement of soil, vegetation and other materials that contain pesticide residues

Movement of pesticides depends on pesticide characteristics, site characteristics, and pesticide application practices.

Pesticide Characteristics. Once released into the environment, pesticides dissipate at varying rates. Dissipation characteristics influence a pesticides’ potential to harm the environment. Such characteristics include:
• degradation – the ability to break down in the environment
  • pesticides are broken down by microbes, chemical reactions and sunlight
  • the faster a pesticide degrades in the soil, the less likely it is to be carried to aquatic systems and ground water
• volatility – ability to turn into fumes
• solubility in water – ability to dissolve in water
  • soluble pesticides can leach through soil to ground water
• adsorption – the ability to bind onto soil particles
  • pesticides that bind to soil particles are less likely to contaminate water
• absorption – ability to move into organisms or materials
• bio-accumulation – ability to accumulate in tissues
• toxicity – the degree to which a substance is harmful or poisonous

When selecting pesticides, choose ones with the shortest degradation period, lowest volatility, lowest solubility, highest capacity to bind onto soil, and lowest toxicity.

**Site Characteristics.** Site conditions affecting pesticide movement include:

• the infiltration and permeability of soil
• the binding capacity of soil to hold pesticides
  ➔ see Contaminant Movement in Soil, page 8-15
• the closer the water table is to the surface, the greater the contamination risk
• the closer proximity to surface water bodies, the greater the contamination risk
• the steeper the slope, the greater is the risk of runoff (slope direction determines runoff path)

If a site is likely to pose a high risk of pesticide movement, select crops or production methods that require little or no pesticide application.

**Pesticide Application Practices.** Application characteristics affecting the movement of pesticides include:

• application method – direct-applied pesticides (wipe-on) have a lower risk than sprayer-applied
• droplet size – coarse droplets are less prone to drift than fine droplets
• application rate – lower rates decrease the risk of runoff and leaching

When selecting pesticide application equipment, check the label information. If feasible, choose methods that wipe-on chemical or produce coarse droplets, and have low application rates.

[http://www.agf.gov.bc.ca/pesticides/h_1.htm](http://www.agf.gov.bc.ca/pesticides/h_1.htm)
**Pesticide Transport**  
When transporting pesticides, implement the following practices:

- transport only pesticide containers that are undamaged, properly labelled and securely closed
- secure pesticide containers in transport vehicles
- transport in a separate compartment from people, animals, food or clothing
- place pesticides on non-absorbent materials such as metal or plastic (wood is not considered a preferred material to wash spillage from)
- carry a pesticide spill cleanup kit

**Pesticide Storage**  
When storing pesticides, implement the following practices:

- store following label directions
- use a locked, dry, vented to outside building posted with a “Warning – Chemical Storage – Authorised Person Only” warning sign on the door
- locate the building away from yard drains, ditches, wells, and watercourses
  - at least 30.5 m from any well (*Public Health Act*)
  - 15 m or more from watercourses (suggested)
  - 30 m or more from a water intake used for domestic purposes (suggested)
- construct the storage with curbs of concrete or other impervious material that will contain spills and allow for easy cleanup
- site to protect the storage from collision by vehicular traffic
- store pesticides in their original containers and close containers tightly
- if the original container is damaged, place pesticide in a suitable container
- if the original label is illegible or missing, obtain a replacement label from the supplier or website [http://www.agf.gov.bc.ca/pesticides/](http://www.agf.gov.bc.ca/pesticides/)
  - and label container with the name, trade name, concentration of active ingredient, and PCP registration number
- do not store food, feed, fertilizer, seed, livestock or livestock medication with pesticides
- store herbicides separate from other pesticides to prevent cross-contamination
- locate a pesticide spill cleanup kit nearby
- store pesticide-treated seed in areas where animals, including wildlife will not come in contact with the seed
- keep an updated list of stored pesticides in case of fire or spill emergencies
- keep a list of emergency phone numbers in a convenient location known by all farm workers
- Refer to Figure 5.1, for an example of a pesticide storage shed.

*On Farm Pesticide Storage and Handling Facilities*
Pesticide Use

Use Integrated Pest Management (IPM) principles to determine if and when pesticides may be needed. Only use pesticides that are registered for a particular pest and crop. Pesticide labels have environmental protection information (such as buffer zones). Follow the specified uses and instructions on the label to minimize impacts to the environment. 

http://www.agf.gov.bc.ca/pesticides/ for a link to label information

Pre-Application. Before mixing pesticides, implement the following practices:

- ensure that the correct pesticide is selected for a given pest
- read the entire label carefully, including any attached booklets, and follow safety precautions and instructions
- pesticides can only be applied via aerial application or chemigation if it is stated on the pesticide label
- know the size of the crop area to be treated and know exactly how much pesticide is required for that area to avoid excess chemical disposal
- if spraying near an environmentally sensitive area, ensure that the pesticide can be used safely
  - determine the size and type of buffer zone needed to protect the sensitive area
    ➔ see Buffer Zones, page 5-20
- ensure that the application equipment is in good working order
- ensure that equipment is calibrated
- be prepared to handle a spill
Equipment Calibration. Before mixing pesticides, ensure the equipment will apply the correct amount uniformly by completing a thorough calibration. Implement the following four-step equipment calibration practice:

♦ Step 1: set-up of the equipment (usually the most time-consuming step, but one that must be done to ensure uniform and properly targeted application)
  • ensure there are no leaks, the spray boom is properly arranged for the target, and the swath width and driving pattern are determined
  • select nozzles, spray pressure and spray volume
  • measure the output of individual nozzles for uniformity and wear
♦ Step 2: measure the delivery rate of the application equipment
♦ Step 3: adjust the delivery rate, if required, after comparing the measured delivery rate to the rate recommended on the pesticide label or the Production Guide
♦ Step 4: calculate the amount of pesticide to add to the sprayer tank to provide the correct pesticide application rate

Calibration should be done:
♦ before new or altered equipment is used
♦ when making changes that affect the delivery rate
♦ at regular intervals to see if wear is affecting output
♦ at least once a year

various Crop Production Guides, (as listed on page 5-5)
Suggestions for Field Sprayer Operation and Maintenance
Calibration Worksheet – Boom Sprayer

Sprayer Filling and Mixing. To protect the environment at filling and mixing locations, implement the following practices:

♦ install an approved back-flow prevention device on the waterline or ensure that an air gap of at least 30 cm (suggested) between the end of the water supply line and the spray tank exists

♦ locate sprayer filling sites
  • at least 30.5 m from any well (Public Health Act)
  • 15 m or more from watercourses (suggested)
  • at a lower elevation than any wells – if not at a lower elevation, have a berm around the well to divert runoff
  • with buffer areas between it and all watercourses
    ➔ see Buffers, page 11-4

♦ mix only the required pesticide needed for a single day
♦ have spill cleanup equipment such as absorptive materials, personal protective equipment and shovels readily available
♦ after emptying any pesticide container and prior to spraying its contents, rinse the container and pour the rinse water into the sprayer (rinse according to Table 5.3, page 5-23)

Application. While applying pesticides, implement the following practices:

♦ hold a valid Pesticide Applicator Certificate, if required by law
  ➡ http://www.agf.gov.bc.ca/pesticides/h_1.htm
♦ use the application rate specified on the label
♦ maintain an untreated buffer between treated areas and sensitive areas
follow pesticide label setbacks from non-target aquatic and terrestrial areas, and from wells → see Buffers, page 11-4

♦ only apply pesticides by aircraft or chemigation if specified on the label
♦ use GPS guidance systems where appropriate to avoid application overlap
♦ apply pesticides in suitable weather conditions
  • do not spray in strong winds
  • do not apply if heavy rain is expected
♦ protect bees and other beneficial insects by applying pesticides
  • when flowers are not present
  • during early morning or late evening hours when insects are not active
  • away from insect drinking water sources
  • that are least toxic to insects
♦ shut off spray nozzles when they are over non-targeted areas (e.g., while turning on headlands)
♦ incorporate granular insecticides into soil to protect birds and wildlife

Drift Control. Drift refers to the movement of pesticide droplets, dust or vapours, by wind or air currents, away from target areas.

The degree of drift is strongly related to droplet size. The smaller the droplet, the farther wind carries them from the target area. Fine droplets can be carried several kilometres. In addition, larger distances between the sprayer nozzle and the target will result in more drift.

Vapour drift from volatile chemicals can continue long after the spraying operation is completed. Small amounts of highly volatile pesticides can impact susceptible plants and watercourses near treated areas. This can occur even under stable air conditions because vapours tend to flow along the ground without dispersal.

To minimize spray drift, implement the following practices when practical:
♦ replace or clean faulty nozzles to reduce fogging
♦ use nozzles such as low-pressure, flat-fans, flooding, or raindrop nozzles to produce drops more resistant to drift
♦ use shrouded, air-assist or tunnel sprayers
♦ only use special, low-volume sprayers where suitable
  • such sprayers typically produce small droplets more subject to drift
♦ apply pesticides at low spraying pressures to reduce the number of fine spray droplets
♦ keep boom height as low as possible while maintaining uniform coverage
♦ do not spray during strong or gusty wind conditions or during dead calm
  • early morning and evening are often the best times but avoid spraying during conditions when temperature inversions may occur

Use plastic tarps when fumigating soils to contain fumigant. Tarps not only reduce air pollution but increase the effectiveness of treatment. Tarp removal or cultivation of fields too soon after fumigation can result in the release of unwanted pesticide into the air. Plastic used in fumigation should go to a landfill.
Buffer Zones. Many pesticide labels have buffer zone information on the label. The pesticide labels may specify:
- whether the buffer zone is to protect aquatic and/or terrestrial habitat
- what is considered to be aquatic or terrestrial habitat (See Figure 5.2)
- the type of pesticide application equipment that requires a buffer zone
- if and how buffer zones can be reduced; the use of drift reducing spray shields, special nozzles, or other application modifications may allow the applicator to reduce the buffer zone
- and any types of application equipment that do not need a buffer zone
- that the buffer zones on a label are required between the point of direct application and the closest downwind edge of sensitive terrestrial or aquatic habitats
- buffer zones may depend on wind direction
- the size of the buffer zone (see the example in Table 5.2)

<table>
<thead>
<tr>
<th>Table 5.2</th>
<th>Example of a Buffer Zone on a Pesticide Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method of Application</td>
<td>Crop</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Sprayer</td>
<td>Field crops</td>
</tr>
<tr>
<td>Airblast Sprayer</td>
<td>Stone fruits and grapes</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Figure 5.2 Identifying Aquatic and Terrestrial Buffer Zones](Image)

Leaching Control. Pesticides that have a tendency to leach into ground water may have special restrictions on the label. Read and follow these instructions. Be aware of the depth of the ground water and characteristics of the site and pesticides applied.
Runoff Control. Runoff from areas treated with pesticides can pollute streams, ponds, lakes and wells. To reduce pesticide runoff, implement the following practices:

♦ to prevent the application of pesticides immediately prior to a heavy rain, check the weather forecast (rain can wash pesticides off treated surfaces and can cause runoff or erosion to occur from treated areas)
♦ use minimum tillage techniques to reduce soil erosion and runoff of pesticides bound to the soil
♦ leave a buffer of vegetation and plant material around ditches and natural water bodies to filter pesticide-contaminated runoff
♦ collect contaminated runoff, where feasible see Runoff, page 9-42

Equipment Washing. When washing equipment used to apply or mix pesticides, implement the following practices:

♦ clean sprayers as far as conveniently possible from watercourses, ditches, or wells to prevent pesticide movement from runoff into watercourses, or via leaching to ground water
  • cleaning sites must be at least 30.5 m from any well (Public Health Act)
  • 15 m or more from watercourses (suggested)
♦ dispose of wash water by using as a pesticide or by following Table 5.3, page 5-23

Record Keeping. Knowing when, where and how pesticides were applied is a critical part of an IPM program, implement the following practices:

♦ maintain a record of all pesticide applications including the site (field size and location), date, target pest, pesticide and amount used, crop stage, harvest date, application method, spray volume, weather observations, and precautions followed (e.g., buffer zones)
♦ food safety programs and WorkSafe BC also have record keeping requirements; incorporate their requirements into your records
♦ often there are examples of records in Crop Production Guides see, page 5-5 for list of Guides

Pesticide Application to Livestock. Several species of insects and mites attack cattle. Pesticides are available in various formulations to protect livestock from injury and disease associated with pest attack.

Control of Insects and Related Pests of Livestock and Poultry in BC

Pesticides applied to animals for the purposes of reducing disease or applied internally to control arthropods are not considered pesticides and are exempt from the Integrated Pest Management Act and Regulation.

To avoid contamination of soil and water, implement the following practices:

♦ use pour-on or spot treatments in place of whole-body sprays
♦ place self-activated and forced-use pesticide backrubbers at least 30.5 m from wells (Public Health Act) and 15 m from watercourses (suggested)
♦ ensure that backrubbers are not leaking and are adjusted correctly for dispensing appropriate concentrations of insecticide
♦ ensure that used insecticidal ear tags are collected and properly disposed
Pesticide and Pesticide Container Disposal
Disposal of pesticides is complicated and expensive. The best precaution to avoid disposal is through good planning. Plan pesticide purchases to minimize the amount of pesticides stored and the accumulation of unwanted pesticides.

Excess Mixed Pesticide. Implement the following practices:
- reduce the volume of waste by mixing only the amount of pesticide required for a specific application
- do not store excess mixture in spraying equipment for extended periods of time
  - some pesticides may undergo chemical degradation resulting in a decrease in efficacy
- use excess spray mixtures on another crop or at another site if label specifications allow
- do not exceed label application rates by re-spraying treated areas
- do not dump unused mixed pesticide on land or allow to drain into sewers or other piping systems

Excess Concentrated Pesticide. Implement the following practices:
- purchase no more than one year’s supply of pesticide at a time
- return unopened pesticide containers to the manufacturer or dealer
- do not dump unused or unwanted pesticide concentrate on land or allow to drain into sewers or other piping systems
- contact a hazardous waste disposal company or MOE for information on disposal of leftover pesticides
- occasionally there are agricultural unwanted pesticide collection programs that will accept unwanted pesticides from farmers. These collections are advertised at www.al.gov.bc.ca/pesticides, through grower associations, the BC Agriculture Council or pesticide distributors

Disposal of Empty Pesticide Containers. After emptying pesticide containers it is a legislative requirement that all pesticide containers are properly rinsed and disposed of as outlined in Table 5.3. After rinsing the container implement the following practices:
- crush or puncture the container so that it cannot be reused
- dispose of containers at pesticide container collection sites, or safely store for a short time until disposal is more convenient
- do not burn paper or plastic pesticide bags to prevent the release of toxic fumes

Some pesticide dealers in BC now accept properly rinsed metal and plastic containers for recycling. This is the preferred disposal method for containers whereas burial should only be used if there are no other options available. Visit http://www.cleanfarms.ca to find disposal locations and procedures for your region.
Table 5.3 **Hazardous Waste Regulation for Empty Pesticide Containers**

<table>
<thead>
<tr>
<th>Type of Container</th>
<th>Rinsing Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rigid plastic or metal (non-pressurized)</td>
<td>Pressure rinse(^1) for 30 seconds or single rinse 3 times</td>
</tr>
<tr>
<td>Rigid plastic or metal (pressurized)</td>
<td>No rinsing required</td>
</tr>
<tr>
<td>Glass bottle</td>
<td>Rinse(^2) three times</td>
</tr>
<tr>
<td>Paper or plastic bag</td>
<td>Rinse</td>
</tr>
<tr>
<td>Containers labeled “Domestic”</td>
<td>No rinsing required</td>
</tr>
<tr>
<td>Any container type not listed above</td>
<td>As approved by MOE</td>
</tr>
</tbody>
</table>

**Disposal Method for Empty Pesticide Containers**

The owner of a waste pesticide product container that has been emptied and rinsed must recycle or dispose of it:
(a) in an approved landfill, or;
(b) by burying it, but only if;
   (i) the burial location is on land owned or leased by the person owning the container or is on land owned, leased or maintained in a tree farm license as defined in the *Forest Act* by the person owning that container:
   (ii) the burial location is on flat ground, not in a swale and at least 200 m from surface water or a well;
   (iii) the ground does not consist of gravel, sand or other similarly porous material, and;
   (iv) the owner covers it with at least 0.5 m of soil immediately after burial.

**Disposal Method for Container and Equipment Wash Water**

Waste produced by cleaning pesticide application equipment or by rinsing waste product containers must, if practicable, be used in mixing a product solution but, if not practicable, it may be applied to land if the area to which it is applied
(a) is on land to which the product contained in the waste has been applied for purposes of pest control,
(b) is flat ground, not in a swale, and at least 200 m from surface water or any well, and
(c) does not consist of gravel, sand or other similarly porous material.

\* Reg. 63/2009 - these methods must be used for the containers not to be considered a hazardous waste.

\(^1\) pressurized spraying of an appropriate solvent into an empty container for at least 30 seconds

\(^2\) introduce an appropriate solvent into an empty container in an amount not less than 20% of its volume, to close and shake the container so that the solvent makes contact with all interior surfaces, and to open and empty the container

---

**Pesticide Storage Fires**

Pesticide fires are extremely dangerous because they may release highly toxic fumes. Implement the following practices:

♦ keep an up-to-date list of stored pesticides in an easily accessible location separate from the storage
♦ inform local fire department about the type of pesticides stored and location of storage
♦ post a warning sign on all entrance doors to any pesticide storage facility
♦ keep emergency phone numbers posted in an accessible location
♦ keep pesticide storage areas locked
♦ do not store pesticide in glass containers in sunlight
♦ keep fire extinguishers approved for chemical fires near storage areas
♦ store combustible materials away from heating systems

If a fire occurs, call the fire department and keep people upwind and away from the fire. Warn firefighters of the presence of pesticides in the building.
**Pesticide Spills**

Be prepared to handle spills by having a pesticide spill cleanup kit when transporting, storing or using pesticides. Such a kit includes gloves, protective clothing, containers for contaminated waste, tools to collect the waste and absorbent materials such as clay, kitty litter or sawdust.

Report pesticide spills in accordance with all of the following:
- *Public Health Act* (a prescribed person as defined by regulation)
- the *Spill Reporting Regulation* of the *Environmental Management Act* (contact the 24-hour Provincial Emergency Program 1-800-663-3456 to report)
- the Integrated Pest Management Act and Regulation

If a pesticide spill occurs, proper cleaning and decontamination of the area may avoid environmental contamination. Implement the following practices:
- prevent exposure of people and animals to the pesticide and its fumes
- put on appropriate personal protective equipment
- prevent the spread of the pesticide
- cover a liquid pesticide with soil, sawdust or any absorptive material to prevent spread or entry into a watercourse or subsurface drain
- dry formulations can be swept up and reused if they have not become wet or contaminated with soil or debris
- place collected contaminated dry formulations and absorbent material into an empty clearly-labelled garbage container and contact MOE for information on appropriate disposal
- if possible, safely decontaminate the surfaces that the spill has come into contact with
- check the label for specific directions – many pesticides can be detoxified by washing the area with chlorine bleach and detergent – do not use excessive amounts of water
- prevent the wash solution from spreading and contaminating a larger area
- if the spill occurs on the soil, remove the top 5 to 7 cm of soil (suggested), cover the area with lime and uncontaminated soil and contact MOE for instructions on disposal of contaminated material
- if the spill occurs beside a watercourse, remove the top layer of contaminated soil immediately and relocate it to a safe site

---

**Reporting Requirement**

*Under the Spill Reporting Regulation,* pesticide spills greater than 5 litres or 5kg of product, mixture or waste must be reported immediately to the Provincial Emergency Program (PEP) at 1-800-663-3456 (24hr service).

It is very easy to generate more than 5 kg or 5 litres of contaminated materials. By law, MOE must be contacted for advice on the proper method for disposal. If the spill takes place in a public area like a highway, call the local police. If the spill has released pesticide into the environment, contact the 24-hour Provincial Emergency Program (PEP) at 1-800-663-3456.
**Pesticide Contingency Plan**

Have a list of emergency numbers so it is easy to notify emergency responders (such as the local fire department) of the amount and type of pesticide stored and the storage locations. Develop a contingency plan when storing any quantities of pesticides. The plan should provide a timely and effective response to any emergencies involving the release of pesticides into the environment, from:

- accidental spills, such as when transporting, storing, applying or dispensing
- release due to building fires or natural events, such as forest fires, floods, or earthquakes
- release due to vandalism
- application errors, such as applying the wrong pesticide or too much pesticide

[Contingency Plan – Template for On-Farm Planning](#)
## Metric Conversions

<table>
<thead>
<tr>
<th>Metric</th>
<th>Imperial Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 m</td>
<td>10 feet</td>
</tr>
<tr>
<td>5 m</td>
<td>16.5 feet</td>
</tr>
<tr>
<td>8 m</td>
<td>26 feet</td>
</tr>
<tr>
<td>10 m</td>
<td>32 feet</td>
</tr>
<tr>
<td>30 m</td>
<td>100 feet</td>
</tr>
<tr>
<td>30.5 m</td>
<td>100 feet</td>
</tr>
<tr>
<td>122 m</td>
<td>400 feet</td>
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<tr>
<td>50 m³/ha</td>
<td>4,500 gal/acre</td>
</tr>
<tr>
<td>50 tonnes/ha</td>
<td>22 tons/acre</td>
</tr>
<tr>
<td>300 µg/ml</td>
<td>300 ppm</td>
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<tr>
<td>15 µg/g</td>
<td>15 ppm</td>
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<tr>
<td>20 µg/g</td>
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</tr>
<tr>
<td>45 µg/g</td>
<td>45 ppm</td>
</tr>
<tr>
<td>50 kg/ha</td>
<td>45 lbs/acre</td>
</tr>
<tr>
<td>150 kg/ha</td>
<td>135 lbs/acre</td>
</tr>
<tr>
<td>200 kg/ha</td>
<td>180 lbs/acre</td>
</tr>
<tr>
<td>300 kg/ha</td>
<td>270 lbs/acre</td>
</tr>
</tbody>
</table>

Conversions in this table are rounded to a convenient number.  
See Appendix E for exact conversion factor.  
Values from tables and examples are not included in Metric Conversions
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6 SOIL AMENDMENTS

INTRODUCTION

This chapter discusses soil amendment practices for protection of the environment. It contains introductory information on the relationship between soil amendments and the environment. It also contains information on environmental concerns, legislation and beneficial management practices related to:

- nutrient application
- soil conditioner application

SOIL AMENDMENTS AND THE ENVIRONMENT

The primary role of soil amendments is to provide nutrients for crop growth or to provide materials for soil improvement. Misuse of soil amendments can result not only in damage to crops but can also cause negative impacts on the receiving soil, water, air or habitat environment. Pertinent environmental subjects related to soil amendments are listed in alphabetical order below.

Amendments

For the purposes of this publication, soil amendments are defined as all materials applied to the soil on farms as fertilizers and/or soil conditioners.

→ see Legislation, page 6-8.

Note: The term “soil amendment” as defined in the Code of Practice for Soil Amendments refers to specific materials which must be managed in accordance to the Code.

Micronutrients and Metals

Common sources of micronutrients and metals are manure and chemical fertilizer. Some metals are plant micronutrients while some can become contaminants (toxic to soil microorganisms or plants). The availability of these elements varies, depending on soil type and soil pH.

Value of Micronutrients and Metals in Manure. The major micronutrients and metals found in manure are iron, manganese, boron, chlorine, zinc, copper and molybdenum. Under both neutral soil pH and average organic matter conditions, most micronutrients in manure are available to the crop.

Soil pH
**Micronutrients and Metals as Contaminants.** Some micronutrients and metals can pollute the soil if found at excessive levels. The metals of concern typically are arsenic, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, and zinc.

**Nitrogen (N)**

Common sources of nitrogen are manure, chemical fertilizer and nitrogen-fixing plants like legumes and legume residues.

**Value of Nitrogen in Manure.** Manure contains nitrogen in both the inorganic and organic forms. Until the organic matter is biologically decomposed in the soil, nitrogen in the organic form remains unavailable for plant use. Nitrogen in this form is desirable since it exists as a reserve in the soil and is slowly released for plant use. Soil microbes must decompose the organic nitrogen compounds in manure before they are available to plants. The majority of the nitrogen that enters the soil following application is available during the year of application. Most of the remaining nitrogen becomes available within the five years following application.

Livestock manure loses some inorganic nitrogen in the barn and during storage as ammonia by volatilization to the atmosphere. When manure is spread onto land for crop production, some of the remaining inorganic nitrogen may also be subject to volatilization losses.

**Particle Size**

The particle size of materials used as soil amendments affects the efficiency of their utilization in soil and their impact on the environment. Fine particle sized materials such as sawdust can easily be incorporated into the soil and decompose rapidly in comparison to coarser materials such as woodchips. The more rapidly an amendment decomposes, the sooner nutrients from that material are made available for plant uptake. Leaching risk increases as well.

Particle size can also play a role in the loss of soil amendments from fields. Smaller particles are easily suspended in water or wind and are therefore carried away by runoff or erosion.

**Phosphorus (P)**

Common sources of available phosphorus are manure and chemical fertilizer. The expression of phosphorus concentrations and rates is often confusing and can lead to serious calculation errors. Refer to Table 6.1, below.

<table>
<thead>
<tr>
<th>Table 6.1</th>
<th>Phosphorus:Converting P to/from P₂O₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>• phosphorus content in soil or plant material, either total or plant-available form, is often expressed in terms of elemental phosphorus (P)</td>
<td></td>
</tr>
<tr>
<td>• phosphorus application rates for commercial fertilizers are given in terms of P₂O₅ (phosphate)</td>
<td></td>
</tr>
<tr>
<td>• the conversion factors are:</td>
<td></td>
</tr>
<tr>
<td>P₂O₅ = P x 2.291</td>
<td></td>
</tr>
<tr>
<td>P = P₂O₅ x 0.436</td>
<td></td>
</tr>
</tbody>
</table>

**Value of Phosphorus in Manure.** Most phosphorus contained in manure is in the organic form. Its availability is dependent on the rate at which soil organisms break down organic matter and release plant available phosphorus.

Phosphorus is normally fixed strongly by soil particles and therefore not readily available to plants. The ability of soils to bind phosphorus varies based on certain soil properties. For example, phosphorus is generally bound more...
than two times as tightly in Fraser Valley soils in comparison to Okanagan soils, due to differences in soil pH, geology, and soil characteristics. In situations where soil phosphorus levels are high, as when phosphorus has accumulated from regular manure or phosphorus fertilizer applications, the phosphorus fixing capacity of the soil can be low. On such soil, the availability of the phosphorus in manure approaches 100%. In these cases, producers should assume that manure is as effective as chemical fertilizer in supplying phosphorus to crops. If manure is infrequently applied, producers should assume that 50% of the total phosphorus in manure is available to the crop in the year it is applied.

**Potassium (K)**

Common sources of potassium are manure and chemical fertilizer. The expression of potassium concentrations and rates is often confusing and can lead to serious calculation errors. Refer to Table 6.2, below.

<table>
<thead>
<tr>
<th>Table 6.2</th>
<th>Potassium: Converting K to/from K$_2$O</th>
</tr>
</thead>
<tbody>
<tr>
<td>- potassium content is often expressed in terms of elemental potassium (K)</td>
<td></td>
</tr>
<tr>
<td>- potassium application rates for commercial fertilizers are given in terms of K$_2$O (potash)</td>
<td></td>
</tr>
<tr>
<td>- the conversion factors are:</td>
<td></td>
</tr>
<tr>
<td>K$_2$O = $K \times 1.205$</td>
<td></td>
</tr>
<tr>
<td>$K = K$_2$O $\times 0.83$</td>
<td></td>
</tr>
</tbody>
</table>

**Value of Potassium in Manure.** All potassium in manure is available immediately after application.

**pH**

Soil amendments have varying influences on soil pH. Many inorganic fertilizers, particularly nitrogen and sulfur based fertilizers, have an acidifying effect. Potassium and phosphorus-based fertilizers have a neutral effect on soil pH. However, phosphoric acid, a phosphorus-based fertilizer, has an acidifying effect. Organic-based soil amendments such as manure have a high buffering capacity and therefore have a neutral or alkaline effect on soil pH.

**Salts**

Most soil amendments contain salts. The salt content will vary depending on the nature of the amendment. Manure, for example, contains between 10% and 13% salts on a dry weight basis. Composted manure is characterized by higher concentrations. The presence of salt in manure is often directly related to nutrient concentrations within livestock feed.

Excess application of amendments onto land can lead to negative impacts on soil quality and crop production caused by salt effects alone. Salt levels are gauged by a manure’s or soil’s electrical conductivity. Salt content in soil can also be expressed as exchangeable sodium percent.

In areas of low precipitation, high annual doses of manure can adversely affect many crops by increasing soil salinity. In areas of high precipitation, salts may cause short-term problems until they are leached from the root zone. In most cases the leachate does not cause a problem.

**Secondary Nutrients**

**Calcium (Ca).** Common sources of calcium are lime, poultry manure and some chemical fertilizers.

**Magnesium (Mg).** Common sources of magnesium are dolomite lime, magnesium sulfate (i.e., Epsom salts) and some chemical fertilizers.

**Sulphur (S).** Manure and many chemical fertilizers are a source of sulfur.
The purpose of this section is to provide information that will assist in making decisions about whether a soil amendment should be used primarily as a fertilizer or as a soil conditioner.

Soil Amendment Sources

Numerous soil amendment sources are available to producers. These materials may or may not come from the farm.

On-Farm Sources. These amendments include bedding, compost, crop residue, manure, contaminated runoff, silage juice, spoiled feed, washwater, spent soilless media, spent mushroom media, and spent nutrient solution. Table 6.4, page 6-6, outlines the primary fertilizer and soil conditioner distinctions for various on-farm soil amendments.

Off-Farm Sources. These are usually purchased and include chemical fertilizers, chemical conditioners such as lime, soilless media constituents such as perlite, manure from other farms, compost, woodwaste, and non-agricultural wastes such as municipal biosolids. Table 6.5, page 6-7, outlines the primary fertilizer and soil conditioner distinctions for off-farm soil amendments.

Is it a Fertilizer or a Soil Conditioner?

Specific soil amendments have inherent characteristics that determine whether they are to be used primarily as a fertilizer or as a soil conditioner.

Certain materials have properties that allow them to be used as both a fertilizer and a soil conditioner. If this is the case, they should be managed primarily as fertilizers.

Fertilizers. These are defined as any organic material such as manure or inorganic material of natural or synthetic origin such as granular ammonium nitrate that is added to a soil to significantly supply one or more nutrients essential for plant growth. The primary goal of fertilizer application is to provide sufficient nutrients in a balance suitable for crop use. Fertilizers counteract imbalances in the soil and replace nutrients removed by crop harvest.

Organic materials that are classified as fertilizers have a carbon to nitrogen ratio of less than 30 to 1. Table 6.3, next page, outlines criteria based on carbon to nitrogen ratio for determining whether soil amendment materials should be managed as a fertilizer or soil conditioner. Liming products are not considered as fertilizers.

Soil Conditioners. These are defined as any material(s) that contain limited amounts of nutrients, but are managed primarily for their beneficial impact on the biological, physical or chemical nature of the soil. They can also be used as a plant growth medium. Soil conditioners can be organic such as compost or woodwaste or inorganic such as lime or perlite.

Organic soil conditioners typically have high levels of organic matter but are not an immediate or significant source of plant nutrients and have a carbon to nitrogen ratio greater than 30 to 1. Addition of soil amendments with a high...
C:N ratio may result in crop available nitrogen being tied up (immobilized). Nutrients will be temporarily tied up in the soil, unavailable for plant use unless nitrogen is added to the soil to decrease the C:N ratio.

### Table 6.3 Management of Soil Amendments Based on Carbon-to-Nitrogen Ratio

<table>
<thead>
<tr>
<th>C:N ratio</th>
<th>Management Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 20:1</td>
<td>Manage as a fertilizer</td>
</tr>
<tr>
<td>Between 20:1 and 30:1</td>
<td>Material has properties of a fertilizer and a soil conditioner but should be managed primarily as a fertilizer</td>
</tr>
<tr>
<td>Greater than 30:1</td>
<td>Manage as a soil conditioner</td>
</tr>
</tbody>
</table>

**Neither a Fertilizer or a Soil Conditioner?** Some products such as vegetable washwater will have very little or no fertilizer or soil conditioner value, with the result that any application is considered as disposal. Such products require MOE authorization. ➔ see Farm Waste, page 2-13

**Contaminants in Soil Amendments**

Soil amendments can have salt, pH or metal levels that will cause soil pollution. Before bringing any non-agricultural waste onto a farm operation, be aware of any regulations or restrictions related to the use of these materials. For all soil amendments, determine the biological, chemical or physical properties of the materials and determine before hand if they can be used beneficially on the farm. ➔ see Soil Contamination, page 8-16

Producers should be aware of the provisions of the *Federal Fertilizers Act and Regulations* as they relate to the quality of fertilizers and supplements (note the definition of supplement in the Act is less inclusive than this publications definition of soil conditioner). Any products bought or sold in Canada where a claim is being made as to the contents of the product to supply plant nutrients, aid in plant growth or improve the physical condition of soil are required to be registered under the Act. The *Fertilizers Act and Regulations* requires that all regulated fertilizer and supplement products must be effective and safe for humans, plants, animals, and the environment. They must also be properly labelled.

For farms operating anaerobic digesters and importing off-farm products to supplement their energy production, please refer to the [Guidelines for Off-Farm Inputs for Anaerobic Digestion Facilities](http://www.env.gov.bc.ca/epd/industrial/agriculture/digestion.htm) available from [www.bcfarmbiogas.ca](http://www.bcfarmbiogas.ca)
Table 6.4 Managing On-Farm Soil Amendment Sources as Fertilizers or Soil Conditioners

<table>
<thead>
<tr>
<th>Soil Amendment Source</th>
<th>Managed Primarily as Fertilizer</th>
<th>Managed Primarily as Soil Conditioner</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedding</td>
<td>×</td>
<td>✓</td>
<td>• low nutrients</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building Drains</td>
<td>×</td>
<td>×</td>
<td>• check chemistry of water</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compost</td>
<td>✓</td>
<td>×</td>
<td>• characterized by slow nutrient release</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• often applied as both fertilizer and soil conditioner.</td>
</tr>
<tr>
<td>Contaminated Surface Runoff</td>
<td>✓</td>
<td>×</td>
<td>• low in nutrients</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• usually incorporated with liquid manure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop Residue</td>
<td>✓</td>
<td>×</td>
<td>• characterized by variable nutrient levels and C:N ratios</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inert Growing Media</td>
<td>×</td>
<td>×</td>
<td>→ Farm Waste, page 2-13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leachate</td>
<td>?</td>
<td>×</td>
<td>• usually incorporated with liquid manure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• variable nutrient levels</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• normally acidic and high BOD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manure – Liquid</td>
<td>✓</td>
<td>×</td>
<td>• variable nutrient levels</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manure – Solid</td>
<td>✓</td>
<td>✓</td>
<td>• normally a fertilizer but may be used as a soil conditioner if low in nutrients and if C:N ratio greater than 30:1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milkhouse Waste</td>
<td>✓</td>
<td>×</td>
<td>• low in nutrients</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• usually incorporated with liquid manure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortalities</td>
<td>✓</td>
<td>✓</td>
<td>• handle as a compost (see above)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>→ Livestock Mortality Disposal, page 3-37</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silage Effluent</td>
<td>✓</td>
<td>×</td>
<td>• high nutrients and very high BOD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spent Mushroom Media</td>
<td>✓</td>
<td>✓</td>
<td>• variable nutrient levels</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• normally a fertilizer but may be used as a soil conditioner if low in nutrients and if C:N ratio greater than 30:1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spent Nutrient Solution</td>
<td>✓</td>
<td>×</td>
<td>• variable to low nutrient levels</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spent Soilless Media</td>
<td>×</td>
<td>✓</td>
<td>• variable nutrient levels</td>
</tr>
<tr>
<td>Peat/woodwaste based</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spoiled Feed</td>
<td>×</td>
<td>✓</td>
<td>• variable nutrients levels, high BOD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wash water</td>
<td>×</td>
<td>?</td>
<td>• low in nutrients but may contain silt, chemical contaminants or high BOD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• apply at rates not exceeding water absorption capacity of soil to avoid runoff</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woodwaste (not regulated by the Soil Amendment Code of Practice)</td>
<td>×</td>
<td>✓</td>
<td>• normally high C:N ratio</td>
</tr>
</tbody>
</table>

? means material must be tested to determine if it is a fertilizer or a soil conditioner
<table>
<thead>
<tr>
<th>Soil Amendment Source</th>
<th>Managed Primarily as</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fertilizer</td>
<td>Soil Conditioner</td>
</tr>
<tr>
<td><strong>Biosolids</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Class A compost or biosolids other forms</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Compost</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Class A compost other forms</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Commercial Fertilizer</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>solid or liquid organic or inorganic base</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Fish Wastes</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Class A compost other forms</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Food Processing Wastes</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Class A compost other forms</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Liming Materials</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Off-Farm Manure – Liquid</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Off-Farm Manure – Solid</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>includes bedding containing significant amounts of manure</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Off-Farm Spoiled Feed</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Sand or Other ‘Clean’ Soil Material</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Spent Mushroom Media</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Whey</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Woodwaste</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>fresh or composted</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Soil Amendments regulated by the Code of Practice for Soil Amendments</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>fly ash, lime mud, residuals from water treatment, industrial residues of wood pulp and paper residuals</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>All Other Organic Materials</strong></td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td><strong>All Other Inorganic Materials</strong></td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

? means material must be tested to determine if it is a fertilizer or a soil conditioner

Class A compost or biosolids are defined in Organic Matter Recycling Regulation
NUTRIENT APPLICATION

NUTRIENT APPLICATION ENVIRONMENTAL CONCERNS

Primary environmental concerns related to nutrient application are:

♦ application rate exceeding the soil’s ability to assimilate nutrients resulting in water and/or soil pollution
♦ inappropriate method or timing that results in water or air pollution
♦ erosion or soil compaction on wet fields
♦ ineffective buffers or impacts caused by inappropriate placement or location (e.g., close proximity to watercourse, wrong soil type, unsuitable topography, sensitive habitat) that results in:
  • water pollution
  • nuisance odours to neighbours
  • habitat impact

For information on these concerns:

➾ see Crops and the Environment, page 4-1, and refer to Crop Quality
➾ see Impacts on Biodiversity and Habitat, page 7-8, and refer to Impacts to Biodiversity and Habitat
➾ see Soil Quality Factors, page 8-2, refer to Contaminants, and to Micronutrients and Metals
➾ see Water Quality and Quantity Factors, page 9-2, and refer to Contaminants
➾ see Air Quality Factors, page 10-1, and refer to Contaminants, and to Odours

NUTRIENT APPLICATION LEGISLATION

The following is a brief outline of the main legislation that applies to nutrient application.

➾ see page A-1 for a summary of these and other Acts and Regulations

Agricultural Land Commission Act

This Act requires that agricultural land within an Agricultural Land Reserve not be used for non-farm use unless permitted by the Act or its regulations. The Agricultural Land Reserve Use, Subdivision and Procedures Regulation designates the application of the following as suitable for farm use:

♦ fertilizers, mulches and soil conditioners
♦ soil amendments collected, stored and handled in accordance with the Code under the Agricultural Waste Control Regulation
♦ compost produced in accordance with the Code under the Agricultural Waste Control Regulation
♦ compost and biosolids produced and applied in compliance with the Organic Matter Recycling Regulation
Drinking Water Protection Act

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).

- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system.

Environmental Management Act

The Code under the Agricultural Waste Control Regulation lists six specific requirements regarding application of agricultural wastes such as manure, compost, vegetation:

- Section 3: must be collected, stored, handled, used and disposed of in a manner that prevents pollution
- Section 11: must not be directly discharged into a watercourse or ground water
- Section 12: must be applied to land only as a fertilizer or a soil conditioner
- Section 13: must not be applied to land if …. runoff or the escape of agricultural waste causes pollution of a watercourse or ground water
- Section 14: must not be applied on frozen ground, in diverting winds, on areas having standing water, on saturated soils or at rates of application that exceed the amount required for crop growth, if runoff or escape of agricultural wastes causes pollution of a watercourse or ground water, or goes beyond the farm boundary
- Section 30: agricultural products must be managed, used and stored in a manner that prevents the escape of agricultural waste that causes pollution

The Code of Practice for Soil Amendments regulates the storage, sampling, application, and record keeping pertaining to specific types of soil amendments. These include:

- fly ash derived from the burning of wood, other than wood that has been immersed in marine waters
- residuals from primary or secondary treatment of liquid waste produced after 1995 from a pulp or paper mill, including domestic sewage if it is mixed with residual solids
- lime mud derived from pulp or paper mill processes or waste lime
- residuals from the treatment of water for domestic use or use in industrial processes
- industrial residue of wood that has not been treated with glue, paint, a preservative or another substance harmful to humans, animals or plants

The Organic Matter Recycling Regulation has further requirements related to the land application of additional defined nutrient sources such as Class A and B Biosolids and Class A and B Compost.

- Section 5: requires development of a Land Application Plan prior to application of Class A and B Biosolids and Class B Compost
- Schedule 12 lists organic materials covered by the Regulation
Public Health Act

This Act prohibits activities that may cause a health hazard:

♦ Section 15: a person must not willingly cause a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard

♦ The Act has conditions under the Public Health Act Transitional Regulation:
  • Section 18: provides separation distance from wells to be at least 30.5 m from any probable source of contamination (probable source of contamination could include nutrients from agricultural wastes or chemical fertilizers)
  • 122 m from any dumping ground

Wildlife Act

The provincial Wildlife Act protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

Fisheries Act

This Act has two sections of importance regarding the application of nutrients:

♦ Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include nutrients)

♦ Section 38(4): requires reporting infractions of Section 36

Species at Risk Act

This Act has sections that protect listed species, their residence and critical habitat. It applies to federal lands, internal waters (i.e., all watercourses), territorial sea of Canada, and the air space above them.

The provisions of the Species at Risk Act (known as the ‘safety net’) could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

Nutrient Application Beneficial Management Practices

Comply with applicable nutrient management related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

Nutrient Management Reference Guide is a publication that forms part of the Environmental Farm Plan series on Beneficial Management Practices. Its purpose is to optimize nutrient use and to reduce environmental impacts. The Nutrient Balance Assessment, outlined on pages 6-11 to 6-16, will indicate which producers should refer to this publication for further evaluation. It will also be of interest to producers wanting to maximize the value of both manure and inorganic fertilizers. Table 6.8, page 6-16, outlines the basic steps in nutrient management planning.

A Nutrient Management Plan is a technical process to optimize the relationship between farm management techniques, crop requirements, and land application for the purpose of maximizing nutrient use while minimizing environmental impact. The process attempts to balance nutrients on an individual crop or field basis as well as on a whole farm basis. The concept of a whole farm nutrient balance is shown in Figure 6.1.
Nutrient Management Planning

For producers in any of the following four situations, completion of a Nutrient Management Plan is recommended:

1. Farms that may be out of Compliance with Nutrient Application Legislation. This applies to farms that answer “No” to any of the legislative questions on the Nutrient Application Worksheet in the EFP Workbook, and the proposed action is the development of a Nutrient Management Plan.

2. Livestock Producers and Producers of Intensively-Managed Outdoor Horticultural Crops Located over Moderately or Highly Vulnerable Aquifers that are Used for Drinking Water. Examples of such aquifers within the province include, but are not limited to, the Abbotsford-Sumas, Hopington, Grand Forks, Vedder River Fan aquifers and other aquifers referred to in Schedule 5 of the Municipal Sewage Regulation.

3. Significant Manure Nitrogen Generation or Use. Producers that generate or use manure should complete one of the following two assessments:
   - Manure Assessment 1 (Worksheet #4): A Manure Nitrogen Assessment for Farms that Generate Manure (whether the manure is used as a fertilizer on that farm or not), or
   - Manure Assessment 2 (Worksheet #5): A Manure Nitrogen Assessment for Farms that Use Manure as a Fertilizer but do not Generate Manure.
The objective of the assessments is to determine if manure nitrogen generation or utilization are above the values in Table 6.6, below. Farms that apply manure at rates below these values are considered to be at a low risk of causing pollution as long as the manure is being stored, handled and applied in compliance with the Code under the Agricultural Waste Control Regulation.

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Baseline Manure Nitrogen Application Rate (kg N/ha/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-forage (e.g., berries, tree fruits, vegetables)</td>
<td>50</td>
</tr>
<tr>
<td>Forage grass (South Coastal BC)</td>
<td>300</td>
</tr>
<tr>
<td>Forage grass (rest of BC)</td>
<td>200</td>
</tr>
<tr>
<td>Forage corn</td>
<td>150</td>
</tr>
</tbody>
</table>

*Value based on Total Manure N

Farms that apply manure at rates above these values may also be managing their nutrients in full compliance with the Code, but the risk of over-applying nutrients and potentially causing pollution is higher. The actual risk would be specific to the farm being assessed, depending on a variety of factors including crops being grown, yield potential, topography, proximity to watercourses and climate. For farms that apply manure at rates above these values, a Nutrient Management Plan is recommended.

4. **High Soil Phosphorus.** This applies if a farm is located in a phosphorus sensitive area (areas where surface water eventually flows to a lake or pond) and soil test phosphorus levels exceed 80 ug/g in the 0 - 15 cm depth (by the Kelowna soil test method, for mineral soils). Phosphorus sensitive areas include, but are not limited to, the Okanagan Basin, Christina Lake Basin, Thompson River at Kamloops and other sensitive surface waters as defined by Schedule 5 of the Municipal Sewage Regulation.

**Soil Sampling for Nutrient Management**

**Understanding Different Soil Test Methods**

Using Worksheet #4, page 6-14, with the appropriate information from Table 6.7, next page, this assessment compares:
- the amount of manure nitrogen generated by a farm with livestock
- with the calculated baseline value required by the crops on that farm

Follow these four steps on Worksheet #4:
- **Step 1:** estimate the annual manure nitrogen excretion to be applied to the farm
- **Step 2:** calculate the manure nitrogen application for each crop area
- **Step 3:** add the manure nitrogen application values for each crop area to get application for the whole farm
- **Step 4:** a Nutrient Management Plan is recommended if the farm’s manure nitrogen generation is greater than the calculated value for the farm
Using Worksheet #5, page 6-15, with the appropriate information from Table 6.7, below, this assessment compares:

- the amount of manure nitrogen used by a farm without livestock
- with the calculated baseline value required by the crops on that farm

Follow these four steps on Worksheet #5:

- **Step 1**: estimate the annual manure nitrogen use for the farm
- **Step 2**: calculate the manure nitrogen application for each crop area
- **Step 3**: add the manure nitrogen application values for each crop area to get the application for the whole farm
- **Step 4**: a Nutrient Management Plan is recommended if the farm’s manure nitrogen use is greater than the calculated value for the farm

### Table 6.7 Assumed Annual Manure Nitrogen Excretion Values and Manure Nitrogen Concentrations in Storage for Various Animal Types

<table>
<thead>
<tr>
<th>Type of Animal</th>
<th>Assumed Annual Manure N Excretion (kg N/animal)</th>
<th>Average Manure N Concentration (kg N/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef Cattle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cows and Bred Heifers</td>
<td>73</td>
<td>3.4</td>
</tr>
<tr>
<td>Feeder 340 to 500 kg</td>
<td>52</td>
<td>3.4</td>
</tr>
<tr>
<td>Yearling 230 to 340 kg</td>
<td>35</td>
<td>3.4</td>
</tr>
<tr>
<td>Calves 50 to 230 kg</td>
<td>17</td>
<td>3.4</td>
</tr>
<tr>
<td>Dairy Cattle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milking cow including associated replacements</td>
<td>200</td>
<td>1.6 (watery) 2.8 (medium slurry) 4.0 (thick slurry)</td>
</tr>
<tr>
<td>Ducks</td>
<td>0.40</td>
<td>11.8</td>
</tr>
<tr>
<td>Goats</td>
<td>10.5</td>
<td>2.9</td>
</tr>
<tr>
<td>Horses</td>
<td>55</td>
<td>3.3</td>
</tr>
<tr>
<td>Poultry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broiler</td>
<td>0.25</td>
<td>15.8</td>
</tr>
<tr>
<td>Layer plus associated pullets</td>
<td>0.67</td>
<td>10.9</td>
</tr>
<tr>
<td>Hatching Egg Layer plus associated pullets</td>
<td>1.25</td>
<td>9.2</td>
</tr>
<tr>
<td>Turkey</td>
<td>1.12</td>
<td>11.5</td>
</tr>
<tr>
<td>Sheep</td>
<td>6.1</td>
<td>2.9</td>
</tr>
<tr>
<td>Hogs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sow – Farrow to Finish</td>
<td>92</td>
<td>3.5 Liquid</td>
</tr>
<tr>
<td>Sow – Farrow to Wean</td>
<td>19</td>
<td>2.9 Liquid</td>
</tr>
<tr>
<td>Grower / Finisher</td>
<td>10</td>
<td>3.5 Liquid</td>
</tr>
<tr>
<td>Veal</td>
<td>9.9</td>
<td>2.1</td>
</tr>
</tbody>
</table>

*Where available, values are based on BC data. Otherwise, based on American Society of Agricultural Engineers Manure Production and Characteristic Standards (2002 and 2003). If the actual farm situation differs significantly from the foregoing, the value in this table should be adjusted up or down in consultation with your Planning Advisor.

For swine, it is assumed that the manure is in the liquid form. Manure nitrogen concentrations can be extremely variable in liquid systems. The values for liquid manure in this table are based on uncovered manure storage facilities. For farms in high rainfall areas with covered manure storage, multiply the manure nitrogen concentration values by 1.5 or get a manure analysis done and use the on-farm value.
### Question:
Proceed through the following worksheet calculations to assess whether or not a Nutrient Management Plan (NMP) would be recommended for this farm.

### Information:

- **Type of animal** (Refer to Table 6.7*): Poultry Broiler
- **Number of animals**: 50000
- **Portion of manure remaining on the farm after manure export** (value between 0 and 1): 0.10
- **Assumed annual N excretion per animal place** (Refer to Table 6.7*): 0.25 kg N/animal

### Calculations:

**Step 1** Estimate the manure N excreted and remaining on farm, using Equations below:

**Equation:**  
\[
\text{Annual N Excretion/animal place (kg)} = \text{Number of animals} \times \text{Portion of manure left} \times \text{Annual N Excretion/animal place (kg)}
\]

- \(50000 \times 0.10 \times 0.25 = 1250\) kg N

**Step 2** Calculate annual baseline manure N application for crops grown on farm, using Equation below:

**Equation:**  
\[
\text{Manure N Application for Farm (kg)} = \text{Area Manure Spread on (ha)} \times \text{Manure N Application Rate (kg N/ha)}
\]

- **Non-forage area**
  - Area: 6 ha, Manure N Application Rate: 50 kg N/ha, Result: 0 kg N
- **Forage grass (Fraser Valley) area**
  - Area: 7 ha, Manure N Application Rate: 300 kg N/ha, Result: 0 kg N
- **Forage grass (rest of BC) area**
  - Area: 8 ha, Manure N Application Rate: 200 kg N/ha, Result: 0 kg N
- **Forage corn area**
  - Area: 5 ha, Manure N Application Rate: 150 kg N/ha, Result: 750 kg N

**Step 3** Calculate Annual Baseline Manure N application for whole farm
(Sum of boxes 10 to 13) = 750 kg N

### Answer:

**Step 4** Is the annual N excretion remaining on the farm 1250 kg N less than 750 kg N the baseline application value?

- **NO** a NMP is recommended
- **YES** a NMP is Optional

A Nutrient Management Plan (NMP) is suggested to optimize nutrient utilization and protect the environment.

Note: *Refer to Tables in BC Environmental Farm Plan Reference Guide*
Worksheet #5  Manure Nitrogen Application Assessment for Farms that Use Manure but do not Generate Manure  Workbook Question 217

Question: A vegetable farm orders 100 m³ of broiler manure for application onto 10 ha of vegetable crop land.

Proceed through the following worksheet calculations to assess whether or not a Nutrient Management Plan (NMP) would be recommended for this farm.

Information:

<table>
<thead>
<tr>
<th>Type of animal</th>
<th>Poultry Broiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manure Volume (m³)</td>
<td>100</td>
</tr>
<tr>
<td>Average manure N concentration (kg N/m³)</td>
<td>15.8</td>
</tr>
</tbody>
</table>

Calculation:

Step 1 Estimate total N content of manure supply, using Equation below:

\[
\text{Total N content (kg)} = \text{Manure Volume (m³)} \times \text{Assumed manure N concentration (N/m³)}
\]

\[
100 \times 15.8 = 1,580 \text{ kg N}
\]

Step 2 Calculate manure N application value for crops grown on farm, using Equation below.

\[
\text{Manure N Application for Crop (kg)} = \text{Area Manure Spread on (ha)} \times \text{Manure N Application Rate (kg N/ha)}
\]

<table>
<thead>
<tr>
<th>Area Manure Spread on (ha)</th>
<th>Manure N Application Rate (kg N/ha)</th>
<th>Manure N Application for Crop (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>non-forage area</td>
<td>10 x 50</td>
<td>500 kg N</td>
</tr>
<tr>
<td>forage grass (Fraser Valley) area</td>
<td>6 x 300</td>
<td>0 kg N</td>
</tr>
<tr>
<td>forage grass (rest of BC) area</td>
<td>7 x 200</td>
<td>0 kg N</td>
</tr>
<tr>
<td>forage corn area</td>
<td>8 x 150</td>
<td>0 kg N</td>
</tr>
</tbody>
</table>

Step 3 Annual Baseline Manure N application for whole farm = 500 kg N

Answer:

Step 4 Is the manure N content 1,580 kg N less than the baseline application value? NO NMP is recommended

For this vegetable farm example, the estimated N content of the manure brought onto the farm is greater than the calculated annual baseline application of manure N for the farm.

A Nutrient Management Plan (NMP) is suggested to optimize nutrient utilization and protect the environment.
Table 6.8  Steps to Develop a Nutrient Management Plan

1. **Determine On-Farm Nutrient Levels**
   - determine the quantity produced during the year
   - determine the nutrient concentration of various inputs and outputs on a seasonal basis
   - determine the pH and the concentration of micronutrients and salts in inputs and outputs
   - calculate the total and plant-available portion of N, P and K

2. **Determine Field Soil Nutrient Levels**
   - sample the soil and obtain soil test lab reports that predict the amounts of N, P and K that will be available to plants during the growing season (yearly for annual crops and every third year for perennial crops)
   - determine the pH as well as micronutrient and salt concentrations (every three to six years)

3. **Determine Annual Crop Nutrient Requirements** (for each field or greenhouse crop)
   - determine the type of crop and estimate expected yield and quality reasonable for the soil and climate
   - calculate the annual amount of N, P and K required and the time of year required

4. **Determine Field Annual Nutrient Balance** Determine the annual application
   - determine the amount of nutrients that need to be supplied (for N, P and K) for each field by using the following equation

\[
\text{Determining Nutrients to be Supplied}\nonumber
\]

\[
\text{Nutrients to be supplied} = \text{plant requirement} + \text{assumed nutrient loss} - \text{soil provided nutrients}
onumber
\]

- adjust the amount of nutrients to be supplied based on previous years effectiveness monitoring
- base nutrient application for each field on the most environmentally limiting nutrient

5. **Determine Off-Farm Nutrient Supplementation** If on-farm nutrient sources are not sufficient to meet crop nutrient needs, supplementation will be necessary. Off-farm nutrient supplements can include chemical fertilizers, manure from other farms, and selected organic matter sources.
   - determine the nutrient concentration of all off-farm nutrient sources
   - determine the amount of supplements that will be required (for N, P and K) for each field on the basis of plant nutrient requirements by using the following equation

\[
\text{Determining Off-Farm Nutrient Supplements to be Supplied}\nonumber
\]

\[
\text{Off-farm nutrient supplements to be supplied} = \text{nutrients required from the nutrient balance} - \text{farm supplied nutrients applied}
onumber
\]

6. **Determine Nutrient Application Strategy** Determine when and how all nutrients will be applied
   - determine the timing, rate, and method of application by field for each application event
   - determine the buffer requirements for each application by field see Buffers, page 11-4

7. **Determine Farm Nutrient Balance** Determine if there is a surplus or deficit of farm nutrients
   - when a surplus of ‘farm nutrients’ occurs, other sites will be needed to utilize the surplus
   - when a deficit of ‘farm nutrients’ occurs, recalculate nutrient application strategy to maximize nutrient value of manure
   - if a deficit remains after recalculation, then make a determination of the source of supplemental off-farm nutrients and the amount required

---

**On-Farm Nutrient Sources:** are materials generated on the farm such as manure, silage or milk house effluent, yard water, compost, and crop residue

**Annual Application:** is the sum of nutrients required for all crops grown (i.e. multiple harvests) in a field/greenhouse throughout the calendar year

**Assumed Nutrient Losses:** these are the predicted losses of nutrients to soil, water and air that result from the use of specific nutrient sources and application equipment under specific climatic, soil and crop conditions. These losses should be managed so as not to cause pollution.

**Effectiveness Monitoring:** is an assessment of previous year’s crop yield and quality relative to certain environmental indicator, such as changes in soil and water quality

**Environmentally Limiting Nutrient:** is the nutrient which is most likely to cause an environmental impact if applied at rates above crop requirement, such as phosphorus near Interior lakes

**Selected Organic Matter:** are those materials identified in Schedule 12 of the Organic Matter Recycling Regulation
Forage Nutrients

Annual and Perennial Forage Crop Nutrient Uptake. Basic plant growth characteristics and structure play a role in nutrient uptake and soil management. Annual crops by their nature generally have shorter nutrient uptake periods than perennial crops. For example, a perennial forage grass may take up nutrients for as long as 240 days while an annual corn crop will take up nutrients for less than 80 days.

Nutrient uptake in annual forage crops is not constant, but typically follows an S-shaped curve with very low uptake for a period of about 30 days, then increases sharply until flowering, then decreases rapidly with maturity. In a perennial forage crop the curve may be elongated, or in the case of a forage grass or grass/legume mix there will be several periods of varying uptake in response to multiple cuttings. Figure 6.2, below, illustrates such patterns.

Forage grasses are generally subject to a range of harvesting options, which include variations in numbers of cuts, times of cutting, and cutting height. Each of these influences the effectiveness of a grass crop to take up nutrients.

Harvest Date. The time of harvest plays a critical role in nutrient uptake for perennial forages such as grass. Perennial forages produce dry matter and protein in response to cutting frequency, cutting height and grazing practices. These factors can be varied to achieve either maximum dry matter yields or maximum protein yield.

For annual crops harvested at maturity, such as corn, harvest date does not affect nutrient uptake. However, if annual crops are planted late and harvested at an immature stage the full potential nutrient uptake will not be achieved. If the crop was fertilized for mature yields and harvested at an immature stage, there may be excess nutrients remaining in the soil after harvest.

![Figure 6.2: Generalized Dry Matter Accumulation versus Time of Year](image)
Horticultural Crop Nutrients

Nutrient uptake by horticultural crops varies with the type of crop grown. Some tree fruit and berry crops require most of their nutrients in the spring and early summer. Some vegetable crops take up large amounts of nutrients later in the summer and early fall. Manage nutrient applications so that they are available when required to both maximize crop growth and to minimize any potential for leaching.

Nutrient Application Rate. Apply nutrients at rates that do not exceed a crop’s nutrient requirement. This can be calculated based on soil fertility levels, expected yields and nutrient content for a specific crop.

- **Soil Sampling for Nutrient Management**
- **Soil Sampling in Fertilizer Banded Fields**

Implement the following practices when determining nutrient application rates:
- if manure is the primary nutrient source, determine the rate of application by using the procedures in the **Nutrient Management Reference Guide** publication
  - approximate nitrogen application rates for high-yielding crops are given in Tables 6.9 and 6.10, next page
- for liquid nutrient sources such as liquid manure, liquid fertilizer or liquids applied by chemigation, apply at rates that do not exceed the soil’s infiltration capacity
- to reduce surface sealing from manure application, one-time application rates should not exceed 50 m³/ha of slurry or 50 tonnes/ha of solid manure, if the manure is not incorporated into the soil immediately after application
- for application of solid and liquid nutrient sources, rates, methods, and timing should not contribute to crop smothering. Refer to **Nutrient Management Reference Guide** publication for calibration
- if plants are grown in soilless media with water-soluble fertilizers such as in greenhouses, base nutrient application rates on nutrient levels in plant drainage water, foliar analysis, or electrical conductivity
  - **Preparing a Complete Nutrient Solution**
  - **On-Site Testing of Growing Media and Irrigation Water**
- for application of solid organic, inorganic, slow-release, or rapid-release fertilizers, do not apply at rates that exceed the soil’s or soilless media’s ability to assimilate salts
  - crops will be damaged by high rates of nutrient availability or release
  - to avoid salt toxicity or physical damage to plants, limit nutrient application rates of specialized fertilizer products to the manufacturer’s or industry’s recommended rate or less
  - in areas where the risk of leaching or runoff is high due to excessive rainfall or irrigation, adjust application rates to reduce that risk
  - see **Irrigation, page 9-18**
  - see **Runoff, page 9-42**

To determine the effectiveness of nitrogen management, soil test for nitrogen after harvest, before heavy rains begin in the fall. Target values for a 0-30 cm sample depth are 15 µg/g N or less for grass and 20 µg/g or less for annual cropped land. A Nutrient Management Plan is suggested if values exceed 30 µg/g for grass, or 45 µg/g for annual cropped land.
### Table 6.9  Percentage Manure to Apply at Various Times of the Year in Coastal Regions

<table>
<thead>
<tr>
<th>Crop</th>
<th>Typical Annual Nitrogen Uptake (^a) (kg N/ha)</th>
<th>Suggested Manure Application as a Percentage of Annual Crop Uptake (^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Feb &amp; March</td>
<td>April &amp; May</td>
</tr>
<tr>
<td>Perennial Grass</td>
<td>260 to 400</td>
<td>up to 25 %</td>
</tr>
<tr>
<td>Silage Corn</td>
<td>190 to 250</td>
<td>0 %</td>
</tr>
<tr>
<td>Berries</td>
<td>50 to 100 (^c)</td>
<td>up to 30 %</td>
</tr>
<tr>
<td>Vegetables</td>
<td>80 to 185 (^c)</td>
<td>up to 10 %</td>
</tr>
<tr>
<td>Cover Crop (^g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emerged before Aug 15</td>
<td>100 to 140</td>
<td>0 %</td>
</tr>
<tr>
<td>Emerged before Sept 15</td>
<td>40 to 60</td>
<td>0 %</td>
</tr>
<tr>
<td>Emerged after Sept 15</td>
<td>20 to 35</td>
<td>0 %</td>
</tr>
</tbody>
</table>

\(^a\) For high yielding crop – better estimates of actual uptake can be obtained by completing a Nutrient Management Plan

\(^b\) Maximum total nitrogen (from manure and chemical fertilizer) applied to the soil not to exceed the crop's annual uptake (i.e., the sum of percent applied for each time period through the year not to exceed 100%).

\(^c\) Maximum nitrogen application depends on type of berries or vegetables

\(^d\) For new plantings, up to 100% of that year’s nutrient need may be applied from June to August

\(^g\) Includes relay crops – post-harvest nitrate test should be below 20 µg/g (0-30 cm) if fertilizing a fall-planted cover crop

### Table 6.10  Percentage Manure to Apply at Various Times of the Year in Interior Regions

<table>
<thead>
<tr>
<th>Crop</th>
<th>Typical Annual Nitrogen Uptake (^a) (kg N/ha)</th>
<th>Suggested Manure Application as a Percentage of Annual Crop Uptake (^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Feb &amp; March</td>
<td>April &amp; May</td>
</tr>
<tr>
<td>Perennial Grass (^c)</td>
<td>200 to 400</td>
<td>up to 5 %</td>
</tr>
<tr>
<td>Silage Corn</td>
<td>150 to 200</td>
<td>0 %</td>
</tr>
<tr>
<td>Cereals (Spring Planted)</td>
<td>50 to 150</td>
<td>0 %</td>
</tr>
<tr>
<td>Cereals (Fall Planted)</td>
<td>50 to 150</td>
<td>up to 5 %</td>
</tr>
<tr>
<td>Berries, Tree Fruits and Grapes</td>
<td>50 to 100 (^e)</td>
<td>0 %</td>
</tr>
<tr>
<td>Vegetables</td>
<td>80 to 185 (^e)</td>
<td>0 %</td>
</tr>
<tr>
<td>Cover Crop (^g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emerged before Aug 15</td>
<td>100 to 140</td>
<td>0 %</td>
</tr>
<tr>
<td>Emerged before Sept 1</td>
<td>40 to 60</td>
<td>0 %</td>
</tr>
</tbody>
</table>

\(^a\) For high yielding crop – better estimates of actual uptake can be obtained by completing a Nutrient Management Plan

\(^b\) Maximum total nitrogen (from manure and chemical fertilizer) applied to the soil not to exceed the crop's annual uptake (i.e., the sum of percent applied for each time period through the year not to exceed 100%).

\(^c\) For grass legume mixes reduce the application of nitrogen in proportion to legume content

\(^d\) Feb & March application in the year following planting

\(^e\) Maximum nitrogen application depends on crop type (i.e. raspberries vs. blueberries or potatoes vs. broccoli)

\(^f\) For new plantings up to 100% of that year’s nutrient need

\(^g\) Includes relay crops – post-harvest nitrate test should be below 20 µg/g (0-30 cm) if fertilizing a fall-planted cover crop
Timing. Implement the following practices when selecting optimum timing for nutrient application:

- for annual and perennial crops that grow from early spring through late fall, apply nutrients in multiple applications (e.g., Tables 6.9 and 6.10, pages 6-19)
- in areas of high rainfall or high leaching risk (e.g., coarse soils), apply nutrients in multiple applications
- match nutrient application to the developmental stage and rate of growth of the crop
  - plants at the beginning and end of their growth cycle require fewer nutrients than during active growth stages
  - apply nutrients prior to the period of rapid uptake
- leave at least three weeks between applications of manure to reduce the risk of soil surface sealing (allows the soil microbes to break up the manure)
- To avoid the transfer of pathogens to crops, berry and vegetable growers should maximize the time between manure application and the crop harvest
- manure should be well incorporated into the soil and kept from contacting non-root vegetables
- apply manure prior to planting vegetables
- apply manure prior to bloom on berries
- do not apply nutrients on excessively wet soils and soils which are cold, frozen or snow covered as these soils are less likely to absorb nutrients (spreading on frozen or saturated soil may be considered a Code violation under the Agricultural Waste Control Regulation)
- apply first application of manure to grassland in the Coastal region between T-sum 200 and 300 (see information box below)

One method to determine when a first application of fertilizer or manure to grassland in the Coastal region is appropriate is the T-sum Calculator. For information on this method, refer to the Pacific Field Corn Association - Farmwest web page at www.farmwest.com (Climate Tab)

Manure or other fertilizer application is not acceptable during certain times of the year if there is a low potential for nutrient utilization by the crop or if there is potential for negative environmental impact. Refer to Monthly Manure Spreading Practice Tables 6.11 and 6.12, pages 6-21 and 6-22. These tables summarize the considerations to be taken into account for nutrient application for various months for Coastal and Interior regions of the province.
Table 6.11  MONTHLY MANURE SPREADING PRACTICES IN THE COASTAL REGION

<table>
<thead>
<tr>
<th>September &amp; October</th>
<th>November to January</th>
<th>February &amp; March</th>
<th>April to August</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Moderate rainfall hence moderate risk.</strong></td>
<td><strong>High rainfall hence high risk.</strong></td>
<td><strong>Moderate rainfall hence moderate risk.</strong></td>
<td><strong>Moderate to low risk.</strong></td>
</tr>
<tr>
<td><strong>Environmental Risks of Contaminating Surface and Drinking Water</strong></td>
<td><strong>Spreading Practices</strong></td>
<td><strong>Spreading Practices</strong></td>
<td><strong>Spreading Practices</strong></td>
</tr>
<tr>
<td><strong>Moderate rainfall hence moderate risk.</strong></td>
<td><strong>High rainfall hence high risk.</strong></td>
<td><strong>Moderate rainfall hence moderate risk.</strong></td>
<td><strong>Moderate to low risk.</strong></td>
</tr>
<tr>
<td>Spreading on grassland to meet crop nutrient needs for this time of year is acceptable. (See Table 6.9, page 6-19)</td>
<td><strong>NO SPREAD PERIOD</strong></td>
<td>For grassland and well established cover crops, it is generally recommended that the first application of manure as a fertilizer should occur near or after the Tsum\textsubscript{200}* has been reached and at a rate which meets crop nutrient needs. (See Table 6.9, page 6-19)</td>
<td>According to crop and soil conditions, apply manure throughout the growing season to meet crop nutrient uptake. (See Table 6.9, page 6-19)</td>
</tr>
<tr>
<td>When cropping after corn, cover crops or grassland planted after September 1 should not receive manure unless the need for nitrogen has been proven by a soil test. There is usually enough nitrogen remaining in the soil for a cover crop or newly seeded grass.</td>
<td><strong>MID NOVEMBER TO END OF JANUARY</strong> Spreading on any crop is not acceptable due to the extreme risk to surface and/or ground water.</td>
<td>Spreading on berry or vegetable crops to meet crop nutrient needs for this time of year is acceptable after mid-February. (See Table 6.9, page 6-19) * Find information on the Tsum at <a href="http://www.farmwest.com">www.farmwest.com</a></td>
<td>Avoid spreading on wet fields or saturated soils.</td>
</tr>
<tr>
<td><strong>SHOULDER PERIOD</strong> Spreading is not acceptable between mid-October to mid-November unless: • grass is actively growing (mean daily temperature above 5°C), AND • soil is trafficable with no significant rain forecast for next 5 days.</td>
<td><strong>SHOULDER PERIOD</strong> Spreading is not acceptable between mid-October to mid-November unless: • grass is actively growing (mean daily temperature above 5°C), AND • soil is trafficable with no significant rain forecast for next 5 days.</td>
<td>Spreading on berry or vegetable crops to meet crop nutrient needs for this time of year is acceptable after mid-February. (See Table 6.9, page 6-19)</td>
<td>Manure applications should be planned to ensure that storage facilities will be as close to empty as possible by October.</td>
</tr>
<tr>
<td>Not acceptable to spread on bare land (harvested corn, vegetables, berries, etc.) or cover crops that emerged after September 15th.</td>
<td>If spreading, apply only on grass fields which are not subject to flooding and/or runoff and only at rates matched to crop nutrient needs. (See Table 6.9, page 6-19)</td>
<td>Not acceptable to spread manure on bare land. Spreading can only occur if planning to plant a crop in the near future.</td>
<td>To avoid food safety concerns, do not spread manure on berry fields between flowering and harvest or on vegetable fields after planting.</td>
</tr>
<tr>
<td>Solid manure with high carbon-nitrogen ratios may be spread and incorporated into the soil as a soil conditioner. Manure should not be managed as a soil conditioner unless a manure test confirms a carbon-nitrogen greater than 30 to 1.</td>
<td>If spreading, apply only on grass fields which are not subject to flooding and/or runoff and only at rates matched to crop nutrient needs. (See Table 6.9, page 6-19)</td>
<td>Not acceptable to apply manure: to fields that are subject to flooding or runoff; or to soils that are frozen or saturated.</td>
<td>Manure not to be spread within 5 m or more of wet ditches or wet watercourses, or 3 m or more from dry ditches or dry watercourses (suggested) – increase buffer width to avoid any contaminated runoff based on soil, soil cover conditions, slopes greater than 5%, and sensitivity of area being protected.</td>
</tr>
<tr>
<td>Manure not to be spread within 8 m or more of ditches or watercourses (suggested) – increase buffer width to avoid any contaminated runoff based on soil, soil cover conditions, slopes greater than 5%, and sensitivity of area being protected.</td>
<td>Manure not to be spread within 10 m or more of ditches or watercourses (suggested) – increase buffer width to avoid any contaminated runoff based on soil, soil cover conditions, slopes greater than 5%, and sensitivity of area being protected.</td>
<td>Manure not to be spread within 8 m or more of ditches or watercourses (suggested) – increase buffer width to avoid any contaminated runoff based on soil, soil cover conditions, slopes greater than 5%, and sensitivity of area being protected.</td>
<td>Manure not to be spread within 5 m or more of wet ditches or wet watercourses, or 3 m or more from dry ditches or dry watercourses (suggested) – increase buffer width to avoid any contaminated runoff based on soil, soil cover conditions, slopes greater than 5%, and sensitivity of area being protected.</td>
</tr>
</tbody>
</table>
### Table 6.12 MONTHLY MANURE SPREADING PRACTICES IN THE INTERIOR REGION

<table>
<thead>
<tr>
<th>September &amp; October</th>
<th>November to February</th>
<th>March to May</th>
<th>June to August</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Environmental Risks of Contaminating Surface and Drinking Water</strong></td>
<td><strong>Spreading Practices</strong></td>
<td><strong>Spreading Practices</strong></td>
<td><strong>Spreading Practices</strong></td>
</tr>
<tr>
<td>Low rainfall hence low risk.</td>
<td>Spreading on crops is acceptable if soil is not frozen, as most of the manure nutrients will be available for the crop next spring. (See Table 6.10, page 6-19)</td>
<td>Spreading on any land is not recommended due to the extreme risk of snowmelt runoff and surface water contamination.</td>
<td>Not acceptable to apply manure: to fields that are subject to flooding or runoff; or to soils that are frozen, saturated or snow covered; or to bare land in March.</td>
</tr>
<tr>
<td></td>
<td>Not acceptable to spread on bare land (harvested corn, vegetables, berries, etc.) or cover crops that emerged after September 1st.</td>
<td>If field access is possible, avoid wet soils which could compact and lead to poor nutrient utilization or poor crop growth.</td>
<td>According to crop and soil conditions, apply manure throughout the growing season to meet crop nutrient uptake. (See Table 6.10, page 6-19)</td>
</tr>
<tr>
<td></td>
<td>Avoid wet areas.</td>
<td>Meet crop nutrient needs for this time of year is if conditions are acceptable to spread. (See Table 6.10, page 6-19)</td>
<td>To avoid food safety concerns, do not spread manure on berry fields between flowering and harvest or on vegetable fields after planting.</td>
</tr>
<tr>
<td></td>
<td>Manure not to be spread within 8 m or more of ditches or watercourses (suggested) – increase buffer width to avoid any contaminated runoff based on soil, soil cover conditions, slopes greater than 5%, and sensitivity of area being protected.</td>
<td>Manure not to be spread within 8 m or more of ditches or watercourses (suggested) – increase buffer width to avoid any contaminated runoff based on soil, soil cover conditions, slopes greater than 5%, and sensitivity of area being protected.</td>
<td>Manure not to be spread within 5 m or more of wet ditches or wet watercourses, or 3 m or more from dry ditches or dry watercourses (suggested) – increase buffer width to avoid any contaminated runoff based on soil, soil cover conditions, slopes greater than 5%, and sensitivity of area being protected.</td>
</tr>
</tbody>
</table>
Nutrient Materials

Selection

In determining which materials should be used to supply a crop’s nutrient requirements, highest priority should be given to on-farm sources such as animal manures. Consider supplementation with off-farm manure sources only to top up deficiencies from the on-farm source.

Particularly in fields where soil phosphorus levels are high and manure is to be applied annually, consider replacing some of the manure nitrogen with chemical nitrogen fertilizer. Chemical fertilizers can provide a faster, more predictable release of nitrogen than manures, especially if the weather is cold and wet, and it is often easier to ensure a more uniform spread of chemical fertilizer than manure. Reducing manure application rates to soils with high phosphorus levels will reduce the risk of phosphorus contaminating adjacent surface waters.

Highly Soluble vs. Slow Release Nutrient Sources. Soil type is a primary consideration in determining application rates and nutrient sources. Fine-textured soils such as clays have higher nutrient holding capacities and thus are better suited to receive higher application rates of highly soluble nutrient sources than medium and coarse-textured soils such as silts and sands. On coarse-textured soils, apply highly soluble nutrients at lower rates but at more frequent intervals.

Alternatively, consider using slow-release nutrient sources such as polymer-coated urea or compost. These nutrient sources are most suitable in areas of high rainfall or where leaching risk is greater such as would be the case for coarse soils.

Particle Size. Incorporate small-sized nutrient material into the soil or apply only to sites with vegetative cover that prevents erosion losses by wind or runoff flow. The advantage of using finely-sized soil amendments is that nutrients are available quicker.

Contaminants. Investigate contaminant levels whenever applying chemical fertilizers or other off-farm nutrient sources.

Nutrient Application

Methods

When selecting chemical fertilizer or manure application equipment, accurate and uniform placement, as well as the capability to calibrate for desired application rate is essential. Ensure nutrients are not applied beyond the target crop by taking into account the spread width of broadcast applicators.

Manure Application. The advantages and disadvantages of various manure spreading methods are shown in Table 6.13, next page. Choose methods that provide uniform placement and which achieve the desired rate of application. Methods that ensure accurate placement on the soil surface or within the crop canopy require smaller buffer distances to sensitive areas.

To reduce damage to crops from manure smothering or soil compaction, place manure under the canopy in as a dilute a consistency as possible. As well, use high flotation tires and low soil disturbance equipment.

Banded Nutrients. For intensively managed row crops such as vegetables, nursery plants, and orchard trees, apply nutrients either in circles around the base of the trees or in bands along the crop row.
Broadcast Nutrients. Broadcast methods of application are suitable for crops such as grass or annually planted vegetables.

Grazing Animals. If grazing livestock are managed at appropriate stocking densities and for appropriate durations, manure deposited by the animals should be evenly distributed and at rates that do not exceed crop requirements. Implement the following practices:

♦ manage for uniform manure distribution by regularly moving water supplies and supplemental mineral and feed sources
♦ ensure livestock are moved frequently to avoid overgrazing and to evenly distribute manure for both rotational and conventional grazing systems

see Outdoor Livestock Areas, page 3-7

Advanced Forage Management and Rangeland Handbook for BC

### Table 6.13 Liquid Manure Application Methods by Order of Preference

<table>
<thead>
<tr>
<th>Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| 1. Band Applicator with or without Soil Aerator (e.g., Sleighfoot or Aerway SSD) | • easy calibration  
• uniform application  
• accurate placement  
• low ammonia loss  
• fertilizer value maximization  
• wider spreading window  
• nitrous oxide release minimization | • higher cost  
• slow application  
• crop damage from wheels if applied when crop is tall  
• soil compaction from tanker |
| 2. Injector | • easy calibration  
• uniform application  
• accurate placement  
• fertilizer value maximization  
• fast application (with hose reel or umbilical systems)  
• ammonia and odour reduction | • high nitrous oxide release (under saturated conditions)  
• only suitable for some soil and crop conditions  
• higher cost  
• slow application (with tanker system)  
• low application rate difficult to achieve  
• short application window  
• soil compaction from tanker |
| 3. Splash Plate | • easy calibration  
• lower cost  
• low nitrous oxide release | • soil and crop compaction  
• short application window  
• high ammonia loss  
• non-uniform application |
| 4. Irrigation Gun | • lower cost  
• fast application  
• low nitrous oxide release | • difficult to calibrate  
• non-uniform application  
• inaccurate placement  
• high risk of runoff  
• short application window  
• high ammonia loss  
• high risk of pathogen, aerosol and odour drift |

Not recommend for use due to odour, calibration, uniformity and placement problems
### Table 6.14 Solid Manure Application Methods by Order of Preference

<table>
<thead>
<tr>
<th>Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Spinning Disks</td>
<td>• easy calibration</td>
<td>• need dry manure</td>
</tr>
<tr>
<td></td>
<td>• accurate placement</td>
<td>• high dust production</td>
</tr>
<tr>
<td></td>
<td>• fast application</td>
<td></td>
</tr>
<tr>
<td>2. Flail Broadcast</td>
<td>• can spread variable moisture content</td>
<td>• inaccurate placement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• non-uniform application</td>
</tr>
<tr>
<td>3. Dump and Grade</td>
<td>• low cost</td>
<td>• cannot be calibrated</td>
</tr>
<tr>
<td>Not recommend for use</td>
<td></td>
<td>• non-uniform application</td>
</tr>
<tr>
<td>due to poor uniformity</td>
<td></td>
<td>• difficult to control rate</td>
</tr>
</tbody>
</table>

**Fertigation.** The application of nutrients through an irrigation or nutrient circulation system is known as fertigation. Fertigation uses the same principles for determining rate and timing of application as any other nutrient application method. Ensure that nutrients are applied only to the target crop and that watercourses are totally avoided. In addition, check the system for leaks on a regular basis.

- Chemigation Guidelines for British Columbia
- Plug and Bedding Plant - Water, Media and Nutrition
- Preparing a Complete Nutrient Solution

### Nutrient Application Equipment Calibration

In order to manage nutrients effectively, both manure and fertilizer spreaders need to be maintained and calibrated to ensure uniform distribution. Calibration is a determination of the amount of solid or liquid applied to a given area for a specific piece of application equipment. To properly calibrate a manure spreader, it is important to know the capacity of the unit, the distance traveled, the spreading band width, and the time it takes to unload the spreader at a chosen tractor speed. When calibrating for solid manure, the manure density must also be known.

Uniformity is the evenness of application across the band spreading width from the beginning to end of each pass. To test uniformity, place buckets, tarps or some other form of collection system at a variety of locations in areas over which the manure is to be spread. The volume or weight of manure can then be measured, and an average can be calculated. A generally acceptable level of uniformity is when all samples are within 15% of the average within the direct spreading area (an area not influenced by previous or subsequent overlapping passes). Minor uniformity problems can be overcome by varying the entry point or direction of travel when spreading manure in a particular field.

- Choosing and Calibrating Manure Application Equipment

### Risk of Pollution During Nutrient Application

**Surface Water.** Any nutrients that enter a watercourse can degrade water quality and impact fish and fish habitat. Select application rates and management practices that keep nutrients out of watercourses.

The rate at which liquid infiltrates into the soil is important in evaluating the risk of runoff. Poorly drained soils become saturated quickly with the result that precipitation can no longer enter the soil, leading to increased stormwater flows. Water ponding on any soil surface is an indication that the liquid is being applied faster than it can infiltrate into the soil. In addition, runoff risks are greater on sloping land. In certain conditions, even a small amount of rain can
create runoff problems. If runoff due to site and weather conditions occurs, stop application, or reduce the application rate. Enlarge buffers to address persistent runoff events.  ➔ see Buffers, page 11-4

If liquid manure is pumped through pipes over or within 10 m of a watercourse, secondary containment on the pipes is suggested to prevent any leakage from entering the watercourse. Where possible pipes should be located 10 m or more (suggested) away from a watercourse.

Manure application should not occur within:
- 3 m or more of a bank or a slope leading to a dry ditch or dry watercourse (suggested)
- 5 m or more of a bank or a slope leading to wet ditch or wet watercourse (suggested)
- at least 30.5 m from any well (Public Health Act)

Commercial fertilizer application should not occur within:
- 1 m or more of a bank or a slope leading to a dry ditch (suggested)
- 3 m or more of a bank or a slope leading to wet ditch or any watercourse (suggested)
- at least 30.5 m from any well (Public Health Act)

In certain circumstances, setback distances to watercourses for manure and commercial fertilizer may need to be increased to avoid contaminated runoff. The determination of an appropriate setback should be based on:
- soil texture, porosity and moisture
- soil cover conditions
- slope toward a watercourse, particularly if slope exceeds 5%
- sensitivity of the watercourse

Spring Runoff. In areas of the province where soils are frozen and where snow accumulates during the winter months, snowmelt has the potential to enter adjacent watercourses. Do not apply manure to frozen or snow covered land if manure can be carried with the melt water and contribute to water contamination.

Subsurface Drains and Macropores. Fields with effective subsurface drainage systems pose a particular pollution risk. Liquid wastes applied to the soil can find its way through macropores in the soil (e.g., cracks, worm holes and mouse or mole holes) into drains and eventually to watercourses. This risk applies to any drained field regardless of slope or its proximity to a watercourse.  ➔ see Drainage Water Quality, page 9-40

Where lowland fields with clays or silt loams have had drainage systems installed at some time in the past, the pipes may still work even if a modern system has not been installed. Where the risk of macropore flow to watercourses is elevated, implement the following practices:
- do not spread manure on grass or bare fields when fields are wet and tile drains are running
- cultivate bare fields to break up macropores shortly before spreading manure (within 7 days)
- reduce one-time manure application rates, depending on soil conditions
- if contamination still occurs, it may be necessary to block the outflow or contain the contaminated drain water and apply to fields as irrigation water when the tile drains are not running

**Greenhouse/Nursery Container Beds.** Check drainage discharge water from greenhouse floor drains or from under nursery container beds and capture and recirculate any contaminated water.

**Ground Water.** In the presence of coarse-textured sandy or gravelly soils or fractured bedrock aquifers, the movement of nutrients and pathogens to ground water is accelerated, creating the potential for pollution. Timing and rate of manure or fertilizer application are important. Follow a nutrient management plan for manure and fertilizer applications in areas over moderately or highly vulnerable aquifers that are used for drinking water. ➔ see Table 6.6, page 6-12
To avoid the risk of contaminating wells from macropore or runoff flow, implement the following practices:
- maintain a 30.5 m manure or chemical fertilizer “no-spread-zone” around well sites (*Public Health Act*)
- protect the well by constructing a secure berm to divert runoff flows away from the well head, and ensure that the well and well casing are properly constructed and maintained

**Weather.** Applications in adverse weather conditions will increase the risk of manure leaving target areas, which may cause pollution. Implement the following practices:
- avoid spreading in diverting winds
- avoid spreading during heavy rains or if significant rain (i.e. greater than 10 mm of rain or its equivalent in snow) is forecast any of the next 3 to 5 days

**Soil, Crop or Crop Residue.** Implement the following practices to reduce the risk of nutrient loss (by surface sealing, ponding, runoff flow and leaching) during and after application:
- apply to an actively growing crop, cover crop or significant crop residue
- apply to soil that is free of surface and subsurface compaction

**Air.** A large portion of the total ammonia and odour emissions from manure occur during land application. The control strategies that can be used include timing and method of spreading.

Choosing an appropriate time to spread manure can go a long way in minimizing complaints due to odour. Using the following as general guidelines, spread manure:
- as soon as is appropriate to land to reduce methane emissions
- when prevailing winds blow away from close urban areas or neighbouring residences
- on cool days to reduce the rate of odour release
- prior to an expected light rainfall or before irrigation
- early in the day to take advantage of increased wind velocities later in the day to dilute odours
- midweek, rather than on weekends or holidays, as this time is less likely to be a nuisance to neighbours pursuing outdoor activities ➔ see Nutrient Application, page 6-20, and refer to Timing
Rapid-cover manure application techniques may ultimately be the best solution in long-term reduction of odour complaints and concerns. Such methods of application are more costly than conventional practices but will maximize returns from the manure as a fertilizer in nutrient savings and won't release as many odours or gaseous emissions.

♦ on ploughed land, follow the spreading of manure closely with a disc or tiller
♦ on perennial forages, consider using a sleigh foot attachment or an attachment that combines a dribble bar with a soil aerator
♦ make more frequent manure applications at lower application rates using sleighfoot or shallow injection equipment for more efficient use of nitrogen

➔ see Nutrient Application, page 6-23, and refer to Nutrient Application Methods

Nutrient Application Impact on Climate Change

The nitrogen from manure and fertilizer can be converted into the greenhouse gas nitrous oxide (N₂O) during periods where the soil is saturated or will become saturated within a short time period as a result of the onset of fall/winter rains or rise in watertables due to subirrigation.

♦ avoid spreading manure or fertilizers in conditions where soil is saturated

➔ see Climate Change Factors, page 12-1

Crop Monitoring and Nutrient Application

Monitor plant health and nutritional status throughout the growing period on an ongoing basis. Implement the following practices:

♦ record all application amounts, conditions, practices, and crop results to assess effectiveness of nutrient application strategies
♦ under highly intensive crop production systems (i.e., greenhouses), monitor pH and electrical conductivity of the rooting medium weekly to determine plant nutritional status throughout the growing period
SOIL CONDITIONER APPLICATION

Refer to previous Table 6.4, page 6-6, and Table 6.5, page 6-7, for decisions regarding the use of soil amendments as a soil conditioner.

SOIL CONDITIONER APPLICATION ENVIRONMENTAL CONCERNS

Primary environmental concerns related to soil conditioner application are:

♦ inappropriate method or timing that results in
♦ soil compaction on wet fields
♦ soil erosion on fields left bare after incorporation of soil conditioners
♦ water pollution caused by runoff of soil conditioners
♦ damage to the crop, leading to poor nutrient uptake or soil erosion
♦ uneven application
♦ application rate exceeding the soil’s ability to assimilate certain soil conditioner components (i.e. salts, pH, carbon-nitrogen ratio, contaminants) that results in
  • water and/or soil pollution
  • nutrient imbalances, plant toxicity and poor growth
♦ over-application of nutrients when managing as a soil conditioner that results in water pollution
♦ applications to unsuitable location (e.g., proximity to watercourse, soil type, topography, sensitive habitat) or ineffective buffers that results in
  • water pollution
  • odour/nuisance to neighbours
  • habitat impact

For more information on these concerns:

⇒ see Crops and the Environment, page 4-1
⇒ see Impacts on Biodiversity and Habitat, page 7-8, refer to Farm Activities and Impacts
⇒ see Soil Quality Factors, page 8-2, refer to all sections
⇒ see Water Quality and Quantity Factors, page 9-2, refer to all sections
⇒ see Air Quality Factors, page 10-1, refer to Odours
SOIL CONDITIONER APPLICATION LEGISLATION

The following is a brief outline of the main legislation that applies to soil conditioner application.

➤ see page A-1 for a summary of these and other Acts and Regulations

**Agricultural Land Commission Act**

This Act requires agricultural land within an Agricultural Land Reserve not be used for non-farm use unless permitted by the Act or its regulations. The Agricultural Land Reserve Use, Subdivision and Procedures Regulation designates the application of the following as farm use:

- mulches and soil conditioners
- soil amendments collected, stored and handled in accordance with the Code under the Agricultural Waste Control Regulation
- compost produced in accordance with the Code under the Agricultural Waste Control Regulation
- compost produced and applied in compliance with the Organic Matter Recycling Regulation

**Drinking Water Protection Act**

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).

- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system

**Environmental Management Act**

The Code under the Agricultural Waste Control Regulation lists specific requirements regarding application of agricultural wastes (manure, compost, vegetation, etc):

- Section 3: agricultural wastes must be collected, stored, handled, used and disposed of in a manner that prevents pollution
- Section 11: agricultural wastes must not be directly discharged into a watercourse or ground water
- Section 12: agricultural wastes must be applied to land only as a fertilizer or a soil conditioner
- Section 13: agricultural wastes must not be applied to land if .... runoff or the escape of agricultural waste causes pollution of a watercourse or ground water
- Section 14: agricultural wastes must not be applied on frozen ground, in diverting winds, on areas having standing water, on saturated soils or at rates of application that exceed the amount required for crop growth, if runoff or escape of agricultural wastes causes pollution of a watercourse or ground water, or goes beyond the farm boundary
- Section 30: agricultural products must be managed, used and stored in a manner that prevents the escape of agricultural waste that causes pollution
The Code of Practice for Soil Amendments regulates the storage, sampling, application, and record keeping pertaining to specific types of soil amendments. These include:

♦ fly ash derived from the burning of wood, other than wood that has been immersed in marine waters
♦ residuals from primary or secondary treatment of liquid waste produced after 1995 from a pulp or paper mill, including domestic sewage if it is mixed with residual solids
♦ lime mud derived from pulp or paper mill processes or waste lime
♦ residuals from the treatment of water for domestic use or use in industrial processes
♦ industrial residue of wood that has not been treated with glue, paint, a preservative or another substance harmful to humans, animals or plants

The Organic Matter Recycling Regulation has further requirements related to the land application of additional defined nutrient sources such as Class A and B Biosolids and Class A and B Compost.

♦ Section 5: requires development of a Land Application Plan prior to application of Class A and B Biosolids and Class B Compost
♦ Schedule 12 lists organic materials covered by the Regulation

Public Health Act

This Act has prohibits a person from willingly causing a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard.

The Act has conditions under the Public Health Act Transitional Regulation:

♦ Section 18: provides separation distance from wells to be at least
  • 30.5 m from any probable source of contamination (probable source of contamination could include soil conditioners)
  • 122 m from any dumping ground

Wildlife Act

The provincial Wildlife Act protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

Fisheries Act

This Act has two sections of importance with respect to the application of soil conditioners:

♦ Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include soil conditioners)
♦ Section 38(4): requires reporting infractions of Section 36

Species at Risk Act

This Act has sections that protect listed species, their residence and critical habitat. It applies to federal lands, internal waters (i.e., all watercourses), territorial sea of Canada, and the air space above them.

The provisions of the Species at Risk Act (known as the ‘safety net’) could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.
Comply with applicable soil conditioner application related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

Certain materials have properties that allow them to be used as both a fertilizer and a soil conditioner. If this is the case, they should be managed primarily as fertilizers.

If intending to apply an amendment primarily as a soil conditioner, ensure the product meets all of the following conditions:

♦ does not fit the criteria of a “fertilizer”
  ➔ see Is it a Fertilizer or a Soil Conditioner?, page 6-4
♦ can be managed to improve physical, biological and chemical soil properties
♦ has been checked for contaminant levels

Soil Conditioner Application

Rate. Apply soil conditioners in a manner that satisfies all the following criteria:

♦ at rates that correct a soil’s deficiency for specific chemical, physical or biological characteristics
♦ at rates within the soil’s capacity to assimilate the specific soil conditioner
♦ at rates that will not lead to crop toxicity or smothering
♦ at rates that do not potentially cause loss of the soil conditioner to the environment by leaching or runoff
♦ for high moisture soil conditioners such as crop wash water, at rates that do not exceed the soil’s infiltration capacity

Mapping - Understanding Your Soil Test Recommendation
Use Caution When Bringing Non-Agricultural Waste or Products onto Your Farm
BC Agricultural Composting Handbook and see Using Compost chapter

Timing. Apply soil conditioners at the appropriate time of year that will avoid the following situations:

♦ high risk of runoff caused by excessive rainfall or irrigation
  ➔ see Irrigation, page 9-18
  ➔ see Runoff, page 9-42
♦ soil compaction on fields where moisture conditions are above field capacity
  ➔ see Soil Management, page 8-7
  ➔ see Drainage, page 9-36
Methods. Optimal methods of application and placement of soil conditioners are dependent on the crop being grown and the reason for applying the material. Implement the following practices:

- for most field crops such as annual vegetables and forages, broadcast soil conditioners uniformly and incorporate into the soil as soon as possible
- for soil conditioners applied as "mulches" to improve water conservation or to alter soil conditions within the target crop's rooting zone, use equipment that will uniformly and adequately cover the primary rooting area (e.g., sawdust placed around blueberry plants)
- for perennial crops for which certain soil conditioners such as lime cannot be incorporated regularly, implement the following practices:
  - reduce the annual application rate to avoid toxicity
  - increase the frequency of application to compensate for reduced rate
  - see Nutrient Application Methods, page 6-23
  - see Soil Management, page 8-7

Application Equipment Calibration. To achieve the desired result with any soil conditioner, calibrate application equipment to ensure that the actual rate of application and placement of material match the intended rate and placement.

Materials Selection. Give the highest priority to using on-farm materials for soil conditioning. If such materials are not available, select the soil conditioner that will best achieve the desired outcome.

- see Tables 6.4 and 6.5, pages 6-6 and 6-7, for a list of frequently-used soil conditioners

Crop Monitoring. Because of their low nutrient content, soil conditioners (particularly ones high in organic matter) are frequently applied at high rates. To assess the effectiveness of application strategies, record all applications, conditions, practices, and crop results.

Although most soil conditioners present a reduced risk of pollution when compared with fertilizers, take the following precautions:

- since many soil conditioners have a high percentage of plant fibre and are very light when dry, they are easily wind blown
- when applied to land, work them into the soil as soon after application as possible
- establish and maintain an adequate buffer between soil conditioner application areas and sensitive areas to prevent nuisance or pollution risks

Risk of Pollution During Soil Conditioner Application
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INTRODUCTION

This chapter defines biodiversity and describes how biodiversity can benefit farm productivity and contribute to long term sustainability. The chapter also discusses farm management practices for protection of the biodiversity of aquatic life, wildlife and plants. It contains information on biodiversity, habitat and stewardship, the complex relationship between biodiversity and agriculture and impacts on biodiversity and habitat. It also contains information on environmental concerns, legislation and beneficial management practices related to:

- aquatic biodiversity
- terrestrial biodiversity
- biodiversity conflicts

This chapter is not intended to provide extensive solutions but to raise awareness and to encourage consideration of fish, other aquatic life, wildlife and plants and their habitat where appropriate in farm management. For information on specific local biodiversity concerns and solutions to conflicts refer to AGRI, MOE and DFO staff or other resource people. The following discussion may not apply to all areas of BC.

BIODIVERSITY AND HABITAT

What is Biodiversity?

Biodiversity is defined as *the variety of all life forms plus the habitats and natural processes that support them*. It includes all forms of life from bacteria, viruses, and fungi to grasses, forbs, shrubs, trees, worms, insects, amphibians, reptiles, fish, birds, mammals, agricultural crops and livestock, and humans. Natural processes include pollination, predator-prey relationships, and natural disturbances such as floods and wildfires.

There are three basic levels of biodiversity: ecosystem, species, and genetic diversity.

Ecosystem Diversity. Ecosystem diversity refers to the variety of ecosystems in a given area and the different ways they function. Ecosystems are all the living (e.g., plants, animals) and non-living things (e.g., soil, water, air) in a given area, plus the interactions that occur among them. Ecosystems can be managed or unmanaged. Most agricultural landscapes are managed ecosystems.
It is important to note that ecosystems exist at different scales. You can find an ecosystem within a single tree, or it can extend across a field, an entire farm, or a large region like a major river basin. Interactions between living and non-living things occur at all these scales at the same time.

Ecosystems develop in response to local conditions, which are influenced by such things as climate patterns, soil types, and topography.

**Species Diversity.** Species diversity refers to the variety of species that occurs within an area or ecosystem. Different types of birds and different types of trees are examples of species diversity. Generally, the greater the number of species in an ecosystem, the more stable it is.

**Genetic diversity.** Genetic diversity refers to the variety of genes within a species. Genes determine individual characteristics such as size, shape, and colour. The different characteristics that exist among breeds of chickens are an example of genetic diversity. It allows species to adapt to changes in their ecosystem or environment.

All of these levels of diversity are intricately connected. Change in one part of the ecosystem can affect the functioning of other parts.

**Benefits of Biodiversity to Agriculture**

Biologically diverse ecosystems provide a number of critically important goods and services that benefit humans. While conserving and enhancing biodiversity may come at a cost to producers, there are immeasurable benefits to farmers and ranchers, including:

- soil formation and retention processes
- maintaining soil productivity and preventing soil loss due to wind and water erosion
- nutrient breakdown, storage and cycling
- making nutrients available to domestic and native plants, preventing organic debris from accumulating, and maintaining water quality
- reduction of pest populations
- helps reduce crop losses
- pollination services
- enhancing yields for pollinator-dependent crops such as fruit trees
- supporting wild species that are a source of the genetic material needed to breed crops and livestock that perform better than existing varieties

The above ecosystem goods and services can reduce the need for inputs such as pesticides and fertilizers, increase the productive capacity of the land, and reduce production risks. They have the potential to maintain or even increase farm profitability. In addition, maintaining biodiversity on agricultural lands can increase land value and provide opportunities to develop agri-tourism and other niche marketing activities.

Managing for biodiversity ensures that agricultural lands can continue to receive the benefits provided by natural systems. Some of those benefits are discussed below.
Enhancing Production. Biologically diverse ecosystems tend to be healthy and productive. Diverse plant communities are generally more productive than communities with little diversity. In modern cropping systems, increased soil biodiversity has been associated with increased soil fertility. Soils with greater biodiversity tend to process and store nutrients and use water more efficiently, and are often less likely to leach nutrients beyond the root zone. Maintaining biologically diverse vegetation and soils can improve productivity by:
♦ improving soil fertility through enhanced nutrient cycling
♦ improving water infiltration and water holding capacity of soils
♦ reducing plant and soil pathogen populations
♦ reducing levels of pollutants
♦ reducing weed populations
♦ increasing grazing capacity

Agricultural productivity also benefits from the presence of diverse populations of wild pollinators, such as hummingbirds, moths, native bees, and other insects. Maintaining a diversity of pollinators increases the quantity, reliability, and duration of pollination services to crops. For example, there are several advantages to maintaining healthy populations of native bees in addition to honeybees:
♦ native bees generally spend more hours during the day pollinating than honeybees
♦ native bees are usually more active in cold and wet weather than are honeybees.
♦ many native bees use “buzz” pollination, which allows them to pollinate crops that honeybees cannot
♦ when native bees compete with honeybees for the same plant, honeybees can become more efficient pollinators
♦ native bees have greater species diversity than honeybees; therefore, they are less susceptible, as a group, to pests and disease
♦ native bees tend to be more efficient at distributing pollen than honeybees

Agricultural landscapes that have a good mix of cropped and non-cropped, natural and semi-natural areas tend to have higher rates of pollination than less complex landscapes.

Stability in Production. Managing for biodiversity creates the foundation for sustainable agriculture. Generally, the more diverse a production system is, the more stable it tends to be. For example:
♦ diverse systems are more resistant to variations in climate, invasive alien species, outbreaks of diseases, and natural disturbances such as floods, wildfires, and windstorms
♦ increasing the genetic diversity of crop and/or livestock varieties can reduce the risk of production failures
♦ maintaining diverse bird and insect communities can help in controlling agricultural pests.
  • studies indicate that birds can suppress insect and rodent populations, at least at medium to low infestation levels
**Flexibility in Production.** Maintaining both native areas and a mix of crop varieties on the farm can maintain biodiversity while providing flexibility in production. For example, creating a shelterbelt that has a diversity of plants can provide:

- wood fibre
- windbreaks
- reduced risk of erosion
- habitat for pollinators and desirable wildlife species
- habitat connections across landscapes
- favourable growing conditions for crops that require shelter or certain microclimates
- buffers against nuisances such as dust, noise, and odours

Additionally, maintaining a diversity of crop and/or livestock varieties may provide flexibility in marketing opportunities for agricultural products. Similarly, using environmentally-friendly management practices may provide an opportunity to market specialty products to consumers who are concerned about the environment and how their food is produced.

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### Agricultural Landscapes are Important to Biodiversity

Agricultural landscapes play a significant role in providing features that are essential for conserving biodiversity. These include:

- an adequate supply of habitat
- structurally diverse habitats
- connectivity between habitat patches
- healthy, functional habitats
- storehouses of genetic diversity

Because valley bottoms and coastal lowlands have longer growing seasons and better soils, these landscapes are more biologically productive than other parts of British Columbia. Greater biological productivity makes these landscapes the best agricultural areas of the province, but it also makes these lands disproportionately important to wildlife. Land conversion from natural ecosystems to agriculture has the potential to impact the province's biodiversity, but beneficial management practices can help to mitigate those impacts and maintain biodiversity.

While living in areas abundant with fish and wildlife is considered a positive lifestyle amenity, it comes with added environmental responsibilities. The extent of development and the intensity with which we manage the landscape mean that impacts to, and conflicts with, wildlife are inevitable. Good stewardship and effective land management mean considering the effects of our activities and employing means to minimize conflicts and maximize benefits. Some of these impacts have been mitigated by farms that:

- provide fish habitat
  - constructed ditches that fish colonize, irrigation reservoirs that are stocked with fish, planted riparian vegetation, assured fish passage at weirs and dams, maintenance of functional riparian areas
- provide planted or protected wildlife feed and habitat
  - critical winter and early spring forage in feed stacks, pastures and fields, and migratory bird stopover points.
- practice plant stewardship
  - grassland management and protection
While all farming systems have an influence on the surrounding biodiversity, the degree and type of influence will vary greatly by virtue of the many differences between farms. The relationship between fish and wildlife and agriculture is complex and is most usefully viewed as providing both benefits to agriculture as well as having costs to agriculture.

**What is Habitat?**

Environmental concerns are often mentioned in the context of their effect on habitat. Habitats in agricultural landscapes provide the things that all species need to survive: water, food, shelter from predators and adverse weather conditions, and places to safely breed, and rear young. Habitat can include land associated with farms, as well as resources such as constructed ditches, forage areas and woodlots.

- see Aquatic Habitat, page 7-14
- see Wildlife Habitat, page 7-21

**Aquatic and Riparian Areas.** All habitats within the agricultural landscape are important, but aquatic and riparian areas are especially significant to both biodiversity and agricultural production. Aquatic areas are considered to be some of the most productive ecosystems on Earth. Aquatic ecosystems interact closely with riparian zones—the areas of lush, green, moisture-loving vegetation that surround wetlands, lakes, streams, and rivers. Riparian areas form a transition zone between aquatic and dry, upland habitats. In their natural state, these areas typically have higher biodiversity than other habitats in agricultural landscapes because they provide shelter, food, breeding and rearing habitat, and safe access to water. The riparian areas along streams and rivers also provide travel corridors for a whole range of organisms that use aquatic and uplands areas. In some intensively farmed areas of the province, retained aquatic and riparian areas provide the only opportunity for connecting habitats.

**Terrestrial Areas.** In agricultural landscapes, terrestrial habitat consists of both native areas, such as forests and grasslands, and semi-natural areas, such as farm woodlots, pastures, hedgerows, and cultivated fields. While native areas within and around farms provide the best opportunity for conserving biodiversity, land that is used for agricultural production is also important.

**Structurally Diverse Habitats.** Structurally diverse habitats have a mix of vegetation types with different heights and forms. This variation in structure provides different types of important habitats for a variety of native species. Farms and ranches that have a mix of cultivated and uncultivated fields, woodlands, hedgerows, fencerows, shelterbelts, and aquatic and riparian areas provide greater structural diversity than operations that have only cultivated fields or native pastures.

**Connections between Habitat Patches.** Corridors that connect patches of native and semi-natural areas provide safe, sheltered travel routes for animals when they are migrating or searching for food and mates, and they provide routes for pollen and seeds to disperse. These corridors also help maintain ecosystem services by controlling erosion, filtering contaminated runoff, acting as windbreaks, and providing opportunities for economic diversification. Grasslands, shelterbelts, hedgerows, woodlands, fencerows, uncultivated areas, gullies, intact riparian areas, and rock outcroppings can be used effectively to provide connections between habitat patches both within an individual farm and between neighbouring properties.
Healthy, Functional Habitats. Habitats that are healthy and functioning properly support higher levels of biodiversity than habitats that have been compromised. Agricultural management practices such as conservation tillage, off-stream watering, and nutrient management can help maintain the health of both native and semi-natural habitats on the farm.

Storehouses of Genetic Diversity. Agricultural operations can act as sources of genetic diversity both by conserving native species and by managing a variety of crops and livestock species. Agricultural practices such as crop rotation, use of winter cover crops and perennial cover, intercropping, and agroforestry contribute to increased levels of biodiversity. Additionally, areas left in native pasture can support a greater diversity of soil microorganisms, native plants, and pollinators than tame pastures.

Crop and Livestock Diversity. Planting a diversity of flowering crops that bloom at different times can provide food and rest areas for native insects such as wild bees, which are important crop pollinators. Adding livestock to a crop-based agricultural production system can also provide many benefits. Manure can be used as a soil amendment. Livestock can be used to control weeds and promote desired plant species and structural diversity in pastures when their levels of grazing, trampling, and rooting are properly controlled. Adding different kinds of livestock to a production system can also increase the effective use of pastures.

Crop rotation provides crop diversity over time. Rotational cropping helps retain normal ecosystem functioning by curbing erosion, improving soil structure, conserving soil moisture, and disrupting insect, disease, and weed cycles. Rotations that include three or more crops usually have fewer problems with pests and require fewer crop inputs. Rotational cropping can also contribute soil nutrients.

Cover Cropping. Using cover crops during crop rotation supports beneficial organisms above and below ground. These organisms help build soils by decomposing organic matter and contributing to nutrient cycling. Additionally, organic matter is often lost from fallow fields that lack vegetation cover because the soil is exposed to wind and water erosion. Using cover crops, such as a fall rye, instead of letting fields remain fallow, can improve water infiltration, storage, and flow, and add to soil nitrogen content. Delayed seeding and the use of winter cover crops can also be beneficial to a number of species, particularly some species of waterfowl, shorebirds and grassland birds.

Perennial Cover. Perennial cover can make a larger contribution to biodiversity than annual crops can because there is generally less disturbance from farm activities such as tillage, seeding, and spraying. This allows plants and animals to follow their life cycles without disruption. Perennial cover can also provide a greater diversity of vegetation structure, which in turn supports more species. Perennial cover can include crops such as hay (tame or native vegetation) or berry bushes. It can also include native and semi-natural areas that have been left for beneficial insects and other wildlife.

Intercropping. Intercropping provides crop diversity and can increase vegetation structural diversity. It can also provide habitat for beneficial insects. For example, sunflowers planted within one metre of vegetable crops can increase the number of beneficial insects found in crops.
Agroforestry. Agroforestry intentionally combines the production of trees with other crops and/or livestock. By integrating a diversity of crop and other plant species, agroforestry can contribute significantly to the structural diversity of habitats.

Species at Risk

A species at risk is defined by the federal Species at Risk Act as an extirpated, endangered or threatened species or a species of special concern. The Act protects species at risk by providing legal protection to species at risk and their residences.

The Act applies to all lands and waters in Canada, but some provisions of the Act only apply to areas of federal jurisdiction, including migratory birds, all waters (sea and fresh) in Canada, as well as all federal lands, including Indian reserves and national parks, and the airspace above them.

Under the Species at Risk Act there are several species listed as either endangered or threatened in BC. A significant number of these occur in areas that could be impacted by agriculture.

http://www.sararegistry.gc.ca
http://www.dfo-mpo.gc.ca/species-especes/home_e.asp


The provisions of the Species at Risk Act (known as the ‘safety net’) could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

http://www.env.gov.bc.ca/atrisk/toolintro.html

IMPACTS ON BIODIVERSITY AND HABITAT

Every time humans interact with their habitat they interact with biodiversity. This is especially evident in any type of resource use, including agriculture. Therefore, it is important to understand the types of interactions that can occur between agriculture and biodiversity and the impacts they may have.

Agriculture changes the landscape and while farm development typically removes specific habitat types, it will also creates other habitat types. For instance, land clearing removes forested habitat and replaces it with fields that may have forage value for some wildlife and waterfowl.

Impacts on habitat may occur as a result of various ongoing general farm activities. Works done near watercourses such as bridge and culvert crossings, or the construction of farm buildings may pose risks to fish and wildlife habitat. Similar risks may occur as a result of transporting, handling, and storing farm products and chemicals. Some of those impacts are listed in the sections below.
**Farm Activities and Impacts**

**Habitat Loss and Fragmentation.** Regions that support agricultural production are among the most altered ecosystems on the planet. Loss of habitat to agricultural development is associated with a disproportionately high number of species at risk in agricultural areas. Agricultural land makes up approximately 7.5% of Canada’s land base, yet more than half of the terrestrial species at risk are found in agricultural areas. Accordingly, agricultural producers, who play an important role in land management, are increasingly being asked to consider practices that help conserve biodiversity.

Agricultural activities can also affect biodiversity by altering the size and shape of habitats and the distances between them. Large areas of connected native vegetation tend to support the highest levels of native biodiversity. However, smaller patches of native and semi-natural vegetation can also support many species and populations. This is particularly true where patches are close to one another or are connected by corridors of perennial cover that allow wildlife to move safely between them.

**Tillage Impacts.** Tillage tends to degrade the diversity of soil micro-organisms found throughout the soil profile. This reduces the efficiency of nutrient cycling, the breakdown of toxins, and the maintenance of soil structure, which are all needed to sustain the productivity of agricultural soils. Mycorrhiza fungi play an important role in maintaining above and below ground biodiversity and soil productivity. These fungi form associations with approximately 80% of the terrestrial plant species in the world, including legumes, flax, sunflowers, corn, and fruit trees. Generally, the fungi make nutrients (i.e., phosphorus, nitrogen, potassium, magnesium, and some micronutrients) available for plant growth. Undisturbed, mycorrhiza fungi grow into long, intricate networks in the soil. They transport nutrients through these networks to the plants’ roots in exchange for carbon.

**Irrigation Impacts.** Many aquatic species, such as fish and amphibians, rely on the maintenance of certain water regimes throughout the year. Changes in water levels, due to control structures and/or irrigation withdrawals, may negatively impact habitat and water quality. In addition, over-irrigating not only depletes surface water and groundwater, it can drown plant roots. It can also reduce nutrient uptake, cool soils, reduce crop quality, and increase erosion as well as nutrient and chemical runoff into watercourses. These impacts affect both aquatic and terrestrial ecosystems and can be detrimental to biodiversity.

**Input Impacts.** Production inputs include fertilizers and pesticides. Depending on the timing and intensity of their use, production inputs can have significant effects on biodiversity. Repeated additions of nutrients in excess of what crops use can destabilize soil conditions, reduce soil organism diversity, and impair soil processes. Improper use of production inputs can also cause water and air pollution. Nutrients, such as nitrogen and phosphorus, can reduce surface water quality by causing overgrowth of aquatic plants and algae. When these plants decompose, the resulting loss of oxygen can be lethal to fish and other aquatic organisms. Overgrowth of some types of blue-green algae can result in the release of toxins that are harmful to a variety of species.

The use of pesticides (particularly insecticides) can have toxic effects on soil organisms, which can impair soil biological processes. Some pesticides can also have adverse effects on beneficial insects, including pollinators such as bees. Most pollinating insects are especially vulnerable to insecticide applications in the cool
of the early morning and when their forage plants are flowering. They can also be affected by chemical drift into non-cropped areas where they nest.

**Grazing Impacts.** When the intensity and timing of grazing and browsing are not properly managed, biodiversity can be negatively affected. When grazing is too intense or too frequent, individual plants become less vigorous. Over time, plant diversity decreases, and grazing-resistant or less preferred species increase in abundance. These impacts can lead to a loss of food and habitat for beneficial insects, amphibians, reptiles, birds, and mammals.

Different species require different types of vegetation structure. Historically, vegetation structural diversity across the landscape was created by fire and a variety of wild herbivores. In agricultural systems, structural diversity can be achieved by managing grazing intensity to maintain mosaics of lightly grazed, moderately grazed, and more heavily grazed areas. This can support greater biodiversity than areas that are grazed uniformly or left ungrazed.

Grazing that is too intense or that occurs at the wrong time of year can affect soils and site productivity by impacting soil organisms, reducing infiltration of water and associated minerals and nutrients, and affecting the exchange of oxygen, carbon dioxide, and other gases in the root zone. Unmanaged grazing can also create areas of bare soil, which can be prime sites for invasive plants to establish, and soil compaction, which can lead to an increased risk of erosion and reduced water quality for fish and aquatic insects.

The timing of grazing activities must also take into consideration the fact that plants and animals can be especially sensitive to disturbance at certain periods during their life cycle. Some animal species may also be vulnerable during certain times of the day.

**Introductions of Invasive Alien Species.** The introduction and spread of alien species poses a threat to ecosystems around the world. These species are sometimes also called "exotic," "introduced," "non-native," "non-indigenous", or "invasive" species. Invasiveness refers to the ability of a plant or animal species to spread beyond its introduction site and become established in new locations. Invasive alien species compete with native species for available resources, and in some cases, contribute to the decline or loss of native species. Invasive plant species, such as spotted knapweed, are well known for their ability to spread rapidly in disturbed and inappropriately grazed areas. They have the potential to reduce agricultural production by competing with native plants for moisture and soil nutrients but often do not provide suitable forage for wildlife or livestock. Invasive alien plant species reduce native biodiversity and can be extremely difficult and costly to control once established.

**Impacts of Genetically Modified Organisms.** Genetically modified organisms (GMOs) are plants, animals, bacteria, or viruses whose genetic makeup have been deliberately altered in a way that does not occur naturally through mating or natural gene recombination. Modification is often designed to improve yield and production by making the organism resistant to disease, insects, and/or pesticides, but it can also be used to enhance or reduce certain traits such as fibre quality or fat content. The growing of GMOs reduces biodiversity because all of the plants within a single species come from a genetically modified source plant, so they are all genetically identical. The overall effects that GMOs have on
biodiversity are not fully understood, and they can differ among crops, environments, and the types of modifications made to the organism.

**Impacts on Wildlife.** Agricultural activities can have impacts on native wildlife species in addition to causing habitat loss. For example:

♦ wild sheep and goats that come into contact with domestic sheep, llamas, or alpacas can be exposed to diseases that do not naturally occur in wild populations and for which they have no natural resistance

♦ agricultural activities can disturb wildlife and cause them to move or be displaced, or can upset their normal life cycle

♦ livestock can trample bird nests

♦ equipment used for haying, cultivating, tree harvesting, etc., can injure or kill wildlife

♦ fencing can cut off wildlife access to travel corridors, winter/spring ranges, feeding areas, and water. Animals can also be injured or killed when trying to jump over or go under fences; birds can be harmed by accidently flying into fences

♦ runoff polluted with manure or fertilizer can harm fish and amphibians

♦ pesticide sprays can injure or kill native pollinators

### Biodiversity Plans

Biodiversity in and around the farm operation can provide varying degrees of environmental benefit. In order for producers to gain a better understanding of biodiversity and plan for biodiversity a more detailed assessment is outlined in the Planning for Biodiversity publication.

Planning for Biodiversity: A Guide for BC Farmers and Ranchers is a publication that forms part of the Environmental Farm Plan series on Beneficial Management Practices. The guide is designed for farmers and ranchers who wish to increase their understanding of biodiversity and what it means to their operations. It offers ideas on how agricultural producers can manage for biodiversity, and it provides some tools for doing so. The guide is the next step beyond the EFP process and is not intended to address regulatory issues specifically. The guide provides an opportunity to assess how the farm operation fits within the eight principles of agricultural biodiversity (see Figure 7.1, next page).
Eight Agricultural Biodiversity Principles

Managing for agricultural biodiversity is about conserving the variety and number of all living things, including both native and domestic species, and the relationships and interactions among them. The principles on the following pages reflect the key relationships and interactions that need to be considered when managing for biodiversity on farms and ranches.

1. Go Native!
   Native areas (wetlands, aquatic areas, riparian areas, forest/woodlands, and grasslands) provide the most important contribution to biodiversity.

2. Semi-Natural is Valuable!
   Semi-natural areas such as shelterbelts, hedgerows, fencerows, buffers, road margins, pastures, and haylands also contribute to the conservation of biodiversity.

3. Watch Out for Aliens!
   Invasive alien species are generally detrimental to the conservation of biodiversity.

4. Location, Location, Location!
   The location, pattern, and seasonal availability of habitat influences the type and amount of biodiversity present.

5. You Gotta Have Connections!
   Connecting native and semi-natural areas on your land, and with neighbouring landscapes, is important to biodiversity.

6. Healthy Ecosystem Wanted!
   The health of the soil and water influences the type and amount of biodiversity present.

7. Nature Loves Variety!
   The number and mix of species present, including crops and livestock, influences the type and amount of biodiversity present.

8. Achieving New Heights!
   Structural diversity - that is, the variation in physical structure of both native vegetation and crops - on your land provides an important contribution to biodiversity.

Figure 7.1 Eight Principles of Agricultural Biodiversity
AQUATIC BIODIVERSITY

AQUATIC BIODIVERSITY CONCERNS

Primary environmental concerns related to protection of fish and other aquatic life are:

♦ contaminants, such as manure, pesticides and sediments, in water that results in fish health concerns
♦ reduced water quantity or low watercourse flows or velocities causing fish habitat loss resulting in reduction of fish food production, fish, and number of fish species
♦ dredging, dyking and channelizing streams that results in fish habitat loss
♦ loss of riparian vegetation that provides shade, leaf litter and insects for fish food
♦ lack of screens or incorrectly-sized screens on water intakes that results in fish population losses
♦ lack of assured fish passage through or around control structures such as dams or weirs

For information on these concerns:

➡ see Impacts on Biodiversity and Habitat, page 7-8, and refer to Farm Activities and Impacts
➡ see Water Quality and Quantity Factors, page 9-2, and refer to Contaminants
➡ see Buffers, Riparian Areas, and the Environment, page 11-2, and refer to Riparian Areas

AQUATIC BIODIVERSITY LEGISLATION

The following is a brief outline of the main legislation that applies to aquatic biodiversity.

➡ see page A-1 for a summary of these and other Acts and Regulations

**Environmental Management Act**

This Act protects against pollution but makes no reference to habitat protection directly. Similarly, the Code under the Agricultural Waste Control Regulation, which is concerned with agricultural wastes, makes no direct references to fish habitat. **Compliance with the Code does not necessarily ensure habitat protection.**

**Fish Protection Act**

The Fish Protection Act enables the protection of fish and fish habitats. Four main objectives of the Act are to ensure sufficient water for fish, enable fish habitat to be protected and restored, improve riparian habitat protection and enhancement, and to give local governments greater powers for environmental planning.

♦ Section 4: prohibits construction of new dams on specified major rivers
Section 6 and 7: allows designation of sensitive streams and recovery plans
such streams would have restrictions placed on new water licenses or approvals, or amendments to existing ones until the stream has recovered

Under the Act and through the Riparian Areas Regulation the province can provide directives to local government to protect riparian fish habitat during their approval/allowance of residential, commercial, and industrial development. This includes residential buildings on land zoned for agricultural purposes.

**Water Act**
This Act and Regulations allows “changes in and about a stream” under an approval, licence, or by regulation:
- Section 9: requires “changes in and about a stream” in accordance with an approval, licence, or order of the Act or Part 7 of the Regulations of the Act

The Water Regulation, Part 7, regulates “changes in and about a stream”:
- Section 40: authorizes Notification to MOE for certain “changes”
- Section 44: lists “changes” authorized (not requiring an approval or licence)

**Wildlife Act**
The provincial Wildlife Act protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

**Fisheries Act**
This Act has several sections regarding aquatic life:
- Sections 20, 21 and 22: fish passage ways, sufficient flow at obstructions
- Sections 27 and 29: prohibits obstructions to fish passage
- Section 30: requires water intakes to be screened to protect fish
- Section 32: prohibits the destruction of fish except by fishing
- Section 35: prohibits harmful alteration, disruption or destruction of fish habitat unless authorized
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include many farm products or wastes)
- Section 37(4): requires approval for work that may impact fish habitat
- Section 38(4): requires reporting infractions of Sections 35 or 36

**Species at Risk Act**
The purpose of this Act is to prevent native species in Canada from becoming extirpated or extinct, to provide for the recovery of endangered or threatened species and to manage species of special concern to prevent them from becoming endangered or threatened. Once a species is legally listed, the Act requires that recovery strategies be developed for extirpated, endangered and threatened species, and that action plans be developed where recovery is feasible.
- Schedule 1 of the Act sets out the legal list of species at risk (extirpated, endangered, threatened and special concern) in Canada.

Where the Act applies, it makes it illegal to kill, harm, harass, capture or take a species at risk, or to possess, collect, buy, sell or trade any individual or parts of an individual that is at risk. The Act also prohibits the damage or destruction of either the residence (for example, the nest or den) or the critical habitat of any species at risk. Critical habitat is legally identified in a posted recovery strategy or action plan.
While the Act applies to all land and waters in Canada, these prohibitions only apply to areas of federal jurisdiction including migratory birds, all waters (sea and fresh) in Canada, as well as to all federal lands, including Indian reserves and national parks, and the airspace above them.

On **private land**, the SARA prohibitions apply only to:
- aquatic species at risk; and
- migratory birds listed in the *Migratory Birds Convention Act, 1994* and also listed as endangered, threatened or extirpated in Schedule 1 of the Act

The provisions of the *Species at Risk Act* (known as the ‘safety net’) could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

Note that SARA prohibitions do not apply to species of special concern, and that species at risk in Canada may also be protected by provincial or territorial laws.

More information about how the Act applies on private land can be found on the Species at Risk Public Registry at:

http://www.sararegistry.gc.ca/involved/you/privland_e.cfm

### AQUATIC BIODIVERSITY BENEFICIAL MANAGEMENT PRACTICES

Comply with applicable aquatic related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

Protection of fish and other aquatic life on farm operations includes practices that not only directly protect them but also protect water quantity and quality, riparian areas, and habitats as well.

When planning work in or near a watercourse, contact Fisheries and Oceans Canada to ensure that it does not harmfully alter fish habitat or cause a deleterious substance to enter water. Designs for works in and about a stream should be submitted to Front Counter BC where an approval or licence is required; or to MOE where works are being carried out under regulation (*Water Act*, Section 9, and *Water Regulations*, Part 7).

**Aquatic Habitat**

For fish and other aquatic life, habitat clearly refers to the water and physical features in watercourses. A holistic view of aquatic habitat includes grassed and wooded areas adjacent to the water that provide various services to aquatic life, the water and the watercourse. Habitat concerns include water quantity, water quality, and the loss of in-stream habitat and riparian vegetation.

Where farm activities are present adjacent to watercourses, they will vary from low to high risk but all will require careful management to protect fish and other aquatic life.
Lakes, Ponds and Wetlands. These still, and slow moving water environments vary widely through the province but share important functions within an ecosystem that should be considered when addressing farm impacts. They typically:

♦ receive and hold water in a watershed reducing runoff peak flows
♦ depending on their size, have low tolerance for contaminants; water quality may easily be impacted
♦ provide important habitat for a wide range of aquatic life and wildlife
♦ have vegetation that varies greatly, some that may be grazed or browsed by livestock
♦ will have reduced functionality if riparian and buffer areas are impacted

Wetlands in BC tend to be small and dispersed across the landscape. Some of our most important wetlands occur in off-channel riverine areas. The draining and filling in of wetlands is a major conservation concern, for wetlands tend to be disproportionately important to wildlife, particularly in the more arid regions of the province.

Streams, Ditches and Floodplains. These moving water environments vary considerably through the province but share similar important features:

♦ stream bank stability, in-stream structure and sinuosity to dissipate the energy of flowing water without significant erosion
♦ riparian vegetation to provide habitat, organic debris inputs and shade
♦ water quality and quantity for multiple uses, including fish and other aquatic organisms, wildlife, and drinking water supply
♦ floodplains that provide high-water relief to help reduce down-stream erosion and flooding, and to provide nutrients and seasonal rearing habitat for fish
♦ ground water influence in controlling and moderating watercourse flow and temperature

Riparian Areas. These areas bordering watercourses usually have vegetation that is different than the surrounding upland area due to the presence of water. Healthy riparian areas are important to aquatic life.

Aquatic Life and Aquatic Habitat Protection

To protect stream habitat and riparian areas implement the following practices:

♦ protect water quality and quantity by following the water quality protection practices listed on the next page
♦ limit the number and use of in-stream crossings by constructing bridges or culverts wherever feasible
♦ perform an annual assessment of riparian health, implement changes identified, and monitor the results of any changes or improvements made (consider the assistance of local environmental enhancement groups)
♦ use planned grazing systems with separate riparian and upland pastures
♦ avoid grazing in riparian areas or schedule grazing in riparian areas to maintain vegetation diversity

Understanding Wetlands: A Wetland Handbook for BC's Interior
Lakes and Wetlands
Wetlands of British Columbia: A Guide to Identification
Wetland Ways: Interim Guidelines for Wetland Protection and Conservation in British Columbia

Streams, Ditches and Floodplains

Chapter 07 BIODIVERSITY 7-15
**Water Quality.** To protect water quality in watercourses that fish and other aquatic life depend on, implement the following practices:

- keep both dissolved and suspended water contaminants out of watercourses
- establish and maintain adequate vegetated buffers directly alongside watercourses ➔ see Buffers, page 11-4
- use special nutrient management practices in buffer areas such as avoiding the spreading of manure in the fall
- manage stormwater to maintain watercourse hydrology and water quality in the state it was prior to land development as much as possible
- maintain wetlands for reducing peak runoff flows and purifying the water
  - where wetlands have been drained, resulting in marginal agricultural land, re-establish the wetland (conservation incentive programs may be available, such as from Ducks Unlimited Canada)
- on annual croplands located near vegetative buffers and riparian areas, use cover crops to limit bare soil areas created by late-season crop harvesting ➔ see Cover Crops, page 4-5 and ➔ see Buffers, page 11-4
- design livestock watering systems to reduce watercourse impacts either by providing controlled access points or no access whatsoever, if appropriate
- use pesticide application methods that reduce the risk of direct drift into watercourses or indirect drift onto runoff flows entering riparian areas
- manage and control grazing programs to avoid negative impacts such as manure deposition or contaminated runoff flow

**Fish Passage at Control Structures.** Water control structures such as reservoir dams, weirs, flood boxes and pump stations on fish bearing watercourses may require fish passage structures. Such structures will be specific to fish species requirements and should be developed after consultation with Fisheries and Ocean Canada. Depending on the structure and location MOE may provide recommendations.

**Water Withdrawals.** Withdraw irrigation and livestock water at or below the licensed rates, and use acceptable water management practices. During exceptionally dry years, consider the unusual impacts to aquatic life from normal water withdrawals. ➔ see Licencing of Surface Water, page 9-12

Surface water withdrawals require screened intakes to protect fish. They are designed for opening size to prevent fish entry and for low water velocity across the screen to prevent fish loss from being drawn against the screen. ➔ see Water Intakes, page 9-16

**Changes In and About a Stream**

When planning any work in or near a watercourse, contact the appropriate agencies to ensure that it does not harmfully alter fish habitat or cause a deleterious substance to enter water.

**Provincial Requirements.** Work that involves “changes in and about a stream” (such as water intakes, stream crossings, etc) requires an approval or licence from Front Counter BC under the *Water Act*, Section 9. Notification to MOE is required for works that may be done in compliance with the *Water Regulation*, Part 7, such as those that do not involve any diversion of water, can be completed in a short period of time, and have little impact on the environment:

- installation, maintenance or removal of stream culverts, clear span bridges, docks or wharves, ice bridges, stream fords, and fences
installation or maintenance of pipeline crossings, drain tile outlets
repair and maintenance of dykes, bridge superstructures
cutting of annual vegetation,
beaver dam removal for drainage purposes with specific restrictions and in compliance with the Wildlife Act.

A Users Guide to Working In and Around Water
Standards and Best Practices for Instream Works (lower mainland)

Federal Requirements. The Fisheries Act requires authorization for work that may impact fish habitat (from Fisheries & Oceans Canada, DFO).

Aquatic Life Establishment

Farm projects that include water impoundment or conveyance, such as reservoirs, ditches, etc. may also provide habitat for aquatic life. Consider consulting with Fisheries and Ocean Canada to see if measures can be taken (consistent with the farm goals) that may assist in creation of aquatic habitat.
TERRESTRIAL BIODIVERSITY

TERRESTRIAL BIODIVERSITY CONCERNS

Primary environmental concerns related to terrestrial biodiversity are:

**Wildlife**
- contaminants, such as manure, pesticides and sediments, in water from agriculture that results in wildlife health concerns
- grazing intensity and timing not properly managed
- reduced riparian health that results in wildlife habitat loss
- land clearing, drainage of wetlands and introduction of weeds that results in
  - wildlife habitat loss
  - loss of habitat connectivity
- pesticide management that results in loss of beneficial insects

**Plants**
- invasive pests that result in reduced populations of native plants
- pesticide management that results in a loss of beneficial native plants

For information on these concerns:
- see Pest Management and the Environment, page 5-1
- see Impacts on Biodiversity and Habitat, page 7-8, and refer to Farm Activities and Impacts
- see Water Quality and Quantity Factors, page 9-2, and refer to Contaminants

TERRESTRIAL BIODIVERSITY LEGISLATION

The following is a brief outline of the main legislation that applies to terrestrial biodiversity.
- see page A-1 for a summary of these and other Acts and Regulations

**Environmental Management Act**
This Act protects against pollution but not habitat directly. Note that the *Code* under the *Agricultural Waste Control Regulation* has no direct references to wildlife habitat. The *Code* is only concerned with agricultural wastes. **Compliance with the Code does not necessarily ensure habitat protection.**

**Plant Protection Act**
Regulations under this Act provide for the prevention of the spread of designated pests (i.e., insect, plant or pathogen) destructive to specific plants.

**Weed Control Act**
This Act imposes a duty on all land occupiers to control designated noxious plants.
**Wildlife Act**

The provincial *Wildlife Act* protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

- Section 7: makes it an offence to alter, destroy or damage wildlife habitat within a wildlife management area
- Section 9: makes it an offence to disturb, molest or destroy a muskrat or beaver house, den or dam unless you are a licensed trapper or have lawful authority to protect property or maintain irrigation or drainage facilities
- Section 33.1: makes it an offence to intentionally feed or attract dangerous wildlife to any land or premises
- Section 34: makes it an offence, except by regulation, to possess, take, injure, molest or destroy a bird or its egg; the nest of an eagle, peregrine falcon, osprey, heron or burrowing owl; or the nest of any bird not mentioned above when the nest is occupied by the bird or its egg

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**Migratory Birds Convention Act**

The Regulation under this Act has sections of importance:

- Section 6: no person shall: disturb, destroy or take a nest, egg, nest shelter, eider duck shelter or duck box of a migratory bird without permit
- Section 24(1): any person may, without a permit, use equipment, other than an aircraft or firearms, to scare migratory birds that are causing, or a likely to cause damage to crops or other property (other control measures require a permit)
- Section 33: no person shall introduce into Canada for the purpose of sport, acclimatization or release from captivity a species of migratory bird not indigenous to Canada except with the consent in writing of the Director
- Section 35(1): prohibits the deposit of oil, oil wastes or any other substance harmful to migratory birds in any area frequented by migratory birds

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**Plant Protection Act**

This Act protects plant life by preventing the importation, exportation and transportation of pests.

- policy directives outline requirements for the importation and/or domestic movement of straw to prevent the introduction and spread of the cereal leaf beetle

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**Species at Risk Act**

The purpose of this Act is to prevent native species in Canada from becoming extirpated or extinct, to provide for the recovery of endangered or threatened species and to manage species of special concern to prevent them from becoming endangered or threatened. Once a species is legally listed, the Act requires that recovery strategies be developed for extirpated, endangered and threatened species, and that action plans be developed where recovery is feasible.

- Schedule 1 of the Act sets out the legal list of species at risk (extirpated, endangered, threatened and special concern) in Canada.

Where the Act applies, it makes it illegal to kill, harm, harass, capture or take a species at risk, or to possess, collect, buy, sell or trade any individual or parts of an individual that is at risk. The Act also prohibits the damage or destruction of either the residence (for example, the nest or den) or the critical habitat of any species at risk. Critical habitat is legally identified in a posted recovery strategy or action plan.
While the Act applies to all land and waters in Canada, these prohibitions only apply to areas of federal jurisdiction including migratory birds, all waters (sea and fresh) in Canada, as well as to all federal lands, including Indian reserves and national parks, and the airspace above them.

- On private land, the SARA prohibitions apply only to:
  - aquatic species at risk; and
  - migratory birds listed in the Migratory Birds Convention Act, 1994 and also listed as endangered, threatened or extirpated in Schedule 1 of the Act

The provisions of the Species at Risk Act (known as the ‘safety net’) could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

Note that SARA prohibitions do not apply to species of special concern, and that species at risk in Canada may also be protected by provincial or territorial laws. More information about how the Act applies on private land can be found on the Species at Risk Public Registry at: 

http://www.sararegistry.gc.ca/involved/you/privland_e.cfm

TERRESTRIAL BIODIVERSITY BENEFICIAL MANAGEMENT PRACTICES

Comply with applicable wildlife biodiversity related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

Wildlife habitat concerns include the reduction or loss of habitat due to the establishment or expansion of farms, such as drainage of wetlands for crop production. Wildlife protection on farm operations includes practices that protect both wildlife and their habitat. Assess the type and density of wildlife on or around a farm to ensure that a desired agricultural development, activity, or operation does not cause adverse affects.

Grasslands. Grasslands cover only 1.5% of BC’s land area, and about 70% is located on privately owned land. Nevertheless, grasslands are important both as wildlife habitat and as forage for grazing livestock. Grasslands often contain species at risk.

Woodlands. Farm woodlots may be operated on privately owned and/or Crown land. Impacts from harvesting trees may affect both fish and wildlife. Specific concerns include the growth management activities, the timing and method of tree removal, the size of harvest area, and post-harvest activities.

Riparian Areas. Healthy riparian vegetation supports a diversity of bird and wildlife species with both food and shelter. This vegetation is particularly important to wildlife, including species at risk, as it is very productive and located next to water. ➔ see Riparian Areas, page 11-13

Wetlands. These still, and slow moving water environments vary widely through the province but share important fundamentals when considering farm impacts. Many wetlands do not have fish, and as such do not have direct legal protection, except as they relate to the Species at Risk Act and to bird nests.
Wetlands are important to biodiversity because the presence of a vast range plant and animal species. They typically:

♦ receive and hold water in a watershed, reducing runoff peak flows
♦ depending on their size, have low tolerance for contaminants; water quality may easily be impacted
♦ provide important habitat for a wide range of aquatic life and wildlife
♦ have vegetation that varies greatly, some that may be grazed or browsed by livestock
♦ will have reduced functionality if riparian and buffer areas are impacted

Understanding Wetlands: A Wetland Handbook for BC’s Interior
Wetlands of British Columbia: A Guide to Identification
Wetland Ways: Interim Guidelines for Wetland Protection and Conservation in British Columbia

Wildlife and Wildlife Habitat Protection

To protect wildlife habitat, implement the following practices:

♦ follow the beneficial practices to protect water quality as previously mentioned in the fish protection section
♦ know the wildlife species on the farm and what habitats are present to determine if there are any threatened or endangered species
http://www.env.gov.bc.ca/cdc/
http://www.sararegistry.gc.ca
http://www.env.gov.bc.ca/atrisk/toolintro.html
♦ perform an annual assessment of habitat health, implement changes identified, and monitor the results of any changes or improvements made
Riparian Management Field Workbook
Planning for Biodiversity: A Guide for BC Farmers and Ranchers
♦ use planned grazing systems that consider impacts on wildlife habitat
♦ improve livestock management to minimize impacts on habitat by
  • using cross fencing to move livestock
  • installing off-stream or off site-watering
♦ use devices such as flushing bars when cutting hay to reduce wildlife mortality
♦ buffer sensitive habitats from loss or alteration due to road and building construction, outdoor livestock areas, land clearing, wetland drainage, cultivation, crop harvest, soil erosion, compaction, and air contaminants that result from agricultural activities ➔ see Buffers, page 11-4
♦ provide wildlife with corridors for moving across the landscape (where appropriate, work with neighbours to establish continuous corridors)
♦ conserve wildlife trees and other habitat features
♦ contain and treat livestock diseases
♦ use Integrated Pest Management (IPM) to decide when and how to control pests

Wildlife Habitat Establishment

Under some circumstances land owners may choose to plant trees and other vegetation specifically for wildlife.

Conservation organizations such as Ducks Unlimited Canada, The Nature Conservancy, The Nature Trust of BC, The Land Conservancy of BC, the Grassland Conservation Council, or local land trusts work in partnership with producers and may have access to funds or incentives to support stewardship activities, particularly for species at risk.

Designing Tree Plantings for Wildlife
Rotten Luck: The Role of Downed Wood in Ecosystems
**PLANT BIODIVERSITY BENEFICIAL MANAGEMENT PRACTICES**

Comply with applicable plant biodiversity related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

**Livestock Management**

Livestock may have an impact on plant biodiversity. The main concerns are over grazing and trampling of sensitive vegetation on native grasslands, rangelands and riparian areas. ➔ see Outdoor Livestock Areas, page 3-7

**Grazing Management Guide**

**Weeds**

Noxious weeds are typically non-native (alien) plants that have been introduced into British Columbia without the insect predators and plant pathogens that help keep them in check in their native habitats. For this reason and also because of their aggressive growth characteristics, these alien plants can be highly destructive, competitive, and difficult to control. Non-native weeds are among the leading cause associated with loss of the natural diversity in the environment.

It is important that any unusual or unfamiliar weeds be reported to AGRI or the Canadian Food Inspection Agency so that the species can be identified for appropriate action to be taken to eradicate the pest before it spreads.

http://www.al.gov.bc.ca/cropprot/weeds.htm

To reduce the possibility of introducing new weeds to a farm, implement the following practices:

- before importing plant material from other countries or provinces, check with the Canadian Food Inspection Agency for permit requirements and other restrictions ➔ www.inspection.gc.ca
- report the presence of any unusual weeds to the nearest AGRI office as soon as possible

To reduce the impact of weeds, implement the following practices:

- learn to identify weeds, particularly at the seedling stage
- prevent problem weeds from going to seed
- always use clean certified seed sources
- practice crop rotation to discourage build up of specific weeds
- use Integrated Pest Management (IPM) to decide when and how to control weeds
- apply appropriate controls at the recommended stage of crop and weed development
- control perennial weeds prior to planting crops
- prevent the movement of weeds to new locations
  - prevent movement that can occur when livestock move from a weed infested area to an uninfested area
  - by cleaning farm equipment before moving from one location to another
- control weeds along farm roads and trails ➔ see Invasive Pests, page 5-5

Seven Steps to Managing Your Weeds: A Manual for Integrated Weed Management in British Columbia

A Guide to Weeds in British Columbia

Invasive Plant Alert: Prevent the Escape of Aggressive Plants

Field Guide to Noxious and Other Selected Weeds of British Columbia

www.invasiveplantcouncilbc.com and www.weedsbc.ca
This chapter has outlined environmental impacts that may occur to biodiversity from a farm operation. However, farms may be affected by impacts from biodiversity.

**Biodiversity Conflict Concerns**

While there are many benefits of managing for biodiversity, it is important to recognize that not all species have a positive effect on agricultural production. There a number of animal species, both native and introduced, that can cause significant impacts on agricultural operations, including damage to infrastructure, loss of growing or stored crops, transmission of diseases, and harassment, injury, or death of livestock. The type of impact often varies by species. Examples of concerns related to biodiversity and agriculture conflicts are:

- deer and rabbits can damage fruit trees
- coyotes can damage drip irrigation lines and emitters
- birds can raid fruit crops and contaminate feeders
- deer and elk can consume standing crops and stored forage
- bears can damage apiaries
- large carnivores such as wolves, coyotes, cougars and bears killing or maiming of livestock; or causing damage to fences and water piping
- waterfowl can consume standing crops and compact soils of cropped fields, particularly during fall migration or overwintering
- waterfowl can transmit infectious disease
- bats, birds, rodents, skunks, beavers and raccoons and other small wildlife can damage buildings by roosting and nesting in attics, digging and denning under foundations, or sheltering within walls
  - causing damage to feed, and crops
  - carrying pathogens that cause disease in humans, such as Tularemia (beaver), Hantavirus (mice)
- birds causing a nuisance concern for affected neighbours from the need to use noise makers for bird control

When viewed on a provincial scale, most wildlife do not negatively affect agricultural production, but when they do, the impacts to individual producers can be significant. It is important to note that producers can manage for biodiversity without necessarily increasing the risk of wildlife-related conflicts. The key is to find an acceptable balance between the benefits and potential costs of managing for biodiversity.
Minimize Wildlife Damage. To aid in reducing conflicts or damage, implement the following practices:

- minimize waterfowl damage
  - delay fall tillage of already harvested fields (waterfowl will use the waste grain or crop residue)
  - straight combine grain crops instead of swathing
  - plant lure or sacrifice crops
  - post harvested fields as “no-hunting” (essentially creating your own lure crop-preventing damage on unharvested crop)
- minimize ungulate (i.e. deer and elk) damage
  - stack bales at least two tiers high, keeping stack edges as straight as possible (prevents climbing) and stack bales near human habitation
  - use farm machinery to prevent access to stacks
  - clean up spilled grain, loose forage and other food sources which may attract wildlife
- follow the pest management strategies in Chapter 5
- minimize the impact of problem wildlife by
  - not attracting them to feed, by disposing of mortalities in an appropriate and timely manner
  - by excluding them from feed, such as with fencing orchards, vineyards, or other high value crop production areas
  - by excluding them from habitat, such as screening culverts to exclude beavers

Beaver Damage Control in Agricultural Areas of B.C.
Control of Beaver Damage
Mitigating Cattle Losses Caused by Wild Predators in British Columbia: A Field Guide for Ranchers

producers are encouraged to follow normal farm practices as defined by the Farm Practices Protection (Right to Farm) Act and as outlined by previous Farm Industry Review Board rulings. See http://www.firb.gov.bc.ca/

Wildlife Damage Control – Interior BC
Wildlife Damage Control – South Coastal BC

various projects and programs have been developed in BC to solve local wildlife conflicts including the following examples:
- The Delta Farmland and Wildlife Trust is voluntary on-farm stewardship organization that encourages demonstration and research. The Trust has supported planting lure crops, grassland set-asides, buffers, and public education and awareness projects
- The Comox Valley Waterfowl Management Project has been involved in monitoring swan behaviour, planting lure crops, developing hazing programs to scare off birds, and encouraging producer/agency/public communication
- Provincial Agriculture Zone Wildlife Program (PAZWP) coordinates crop damage prevention, mitigation and compensation strategies, increases hunting opportunities in agricultural zones and promotes healthy hunter-landowner relationships.
- The Wild Predator Loss Prevention Pilot Project provides education to producers aimed at reducing losses to wild predators and also provides predator response and compensation for verified losses.
### CHAPTER 8 METRIC CONVERSIONS

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Conversions in this table are rounded to a convenient number. See Appendix E for exact conversion factor.

Values from tables and examples are not included in Metric Conversions.
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INTRODUCTION

This chapter discusses soil management practices for protection of the environment. It contains introductory information on soil quality. It also contains information on environmental concerns, legislation and beneficial management practices related to:

♦ soil management

SOIL QUALITY FACTORS

The primary soil quality factors associated with potential environmental impacts are nutrient content, compaction, organic matter content and contaminants.

The Health of Our Soils

The following soil quality factors are listed in alphabetical order. While these factors can be influenced by agricultural production, they also may be influenced by other human activities and natural phenomenon.

Applications of soil amendments high in carbon or nitrogen can alter the carbon-nitrogen (C:N) ratio of soils. In equilibrium, most soils have a C:N ratio in the order of 12:1. Woodwaste, by comparison, has a C:N ratio near 300:1. The application of wastes with a C:N ratio greater than 12:1 will tie up available nitrogen in the soil. Repeated application of high carbon wastes will continue to lower the level of available nitrogen in the soil until a new soil equilibrium is attained. Soils with high C:N ratios will have less nitrogen available for plant use.

Carbon-to-Nitrogen Ratio

Compaction

Soil compaction is the compression of a soil, usually caused by traffic on the site with heavy equipment. It results in a loss of soil structure and aggregate stability, and therefore a reduction in soil porosity. Compaction reduces the movement of water, air, nutrients and soil microbes through the soil. Farm traffic and tillage can result in compaction, particularly when the soil is wet, at either the soil surface or the plow layer. Soils left bare during wet periods, particularly during winter on the South Coast, often have a thin compacted or ‘puddled’ layer at the surface which significantly reduces air and water movement into and out of the soil.
Cover cropping and incorporation of organic matter in the form of crop residue, mulches, compost or manure can help to prevent compaction and may actually restore compacted soils. Timely and appropriate tillage and traffic on fields will also reduce the risk of compaction.

Livestock may also impact soil structure. Poaching, which is the destruction of structure in the upper layers of the soil, is caused by livestock hoof action in poorly drained conditions.

### Potential Soil Contaminants

#### Agricultural Wastes.
Agricultural wastes may contain metals, nutrients, pathogens, salts and organic matter. Examples of agricultural wastes which may be applied to the soil are vegetation wastes such as crop residue, used mushroom media, manure, and manure mixed with bedding (also referred to as litter).

#### Non-Agricultural Wastes.
Non-agricultural wastes may contain metals, nutrients, pathogens, salts, organic matter, other contaminants and petroleum products. These are wastes, such as drywall, glass, biosolids or woodwaste, which are not derived from agricultural operations. They may be applied to soils as amendments or for other specific purposes.

#### Nutrients.
Spills, improper storage and over application of chemical fertilizers or manure may lead to excess nutrient concentrations in soil. An overabundance of any one nutrient can result in toxicity to plants, soil and water pollution, and reduction of crop yield. Excess nutrients not utilized by plants can leach out of the root zone to ground water or be carried into surface waters.

#### Pathogens.
Most pathogens such as bacteria, viruses and parasites die off rapidly when exposed to sunlight and the biological processes which occur in soils. However, there are some that can remain infectious in soils for many years. Some pathogens can be transferred between plants, soils and animals.

#### Pesticides.
Soils can be polluted with pesticides as a result of excessive application rates, inappropriate application methods, improper disposal, and spills. The extent of contamination depends largely on the characteristics of the pesticide, particularly its persistence and solubility. Soil contamination can result in the elimination of beneficial insects, the inhibition of crop growth, and a reduction in viable crop varieties. In addition, domestic animals and wildlife may be harmed when feeding on contaminated crops or when ingesting soil particles that contain pesticides. A particular risk to humans is that pesticide accumulations in plant and animal products can make foods unfit for consumption.

#### Petroleum Products.
Petroleum such as gasoline, diesel and kerosene, and petroleum byproducts such as oils, greases, paints and solvents, are complex organic compounds that may contain metals and other contaminants. Petroleum products that loosely adhere to soil particles are easily washed or leached into surface or ground water, while petroleum products that firmly bind to soil particles may restrict the growth of plants. Petroleum products will degrade by biological means in the soil when conditions are correct.
**Woodwaste.** Woodwaste leachate is acidic and will cause metals and nutrients to be released from the soil. High application rates of woodwaste, either onto the soil surface or by incorporation, will increase the soil carbon-to-nitrogen (C:N) ratio because woodwaste is high in carbon.

Leachate can be generated when soluble materials are dissolved by water passing through them. Soil leachate normally contains soluble nutrients such as nitrates which have not been used by crops. The soil pH is reduced by strongly acidic leachate such as from silage or woodwaste. Low pH makes some metals soluble, allowing them to be leached from the soil. Metals that are beneficial to the soil-crop system are often referred to as trace metals or micronutrients. The application of wastes or fertilizers containing excess metals may result in an unwanted accumulation of metals in the soil. Mineral supplements in feed or mineral licks can result in elevated concentrations of micronutrients or metals, typically boron, copper, zinc and selenium in soils from manure.

Although crop uptake of metals is generally in low amounts due to their relative immobility in soils, avoid metal buildup to prevent reduced crop production and/or toxicity to plants or animals. Because metal solubility is pH dependent, changing the soil pH will change the potential for metal leaching. Refer to pH and Figure 8.2, page 8-5.

**Nitrogen (N)**

**Nitrogen.** The nitrogen cycle in agricultural soils is illustrated in Figure 8.1, next page. Nitrogen exists in two forms, inorganic and organic. The sum of these two forms of nitrogen is referred to as ‘Total Nitrogen’. The inorganic forms (ammonium/ammonia and nitrate/nitrite) are the simple soluble forms that plants use. Inorganic nitrogen represents between two and five percent of the total nitrogen in soil. The organic forms are complex insoluble forms.

**Inorganic Nitrogen – Ammonium (NH₄⁺).** Ammonium is a common form of inorganic nitrogen used by plants, and is found in soil, fertilizer, manure and compost. After application to land, ammonium is converted by soil bacteria to nitrate (NO₃⁻) form. Because ammonium is soluble, it is found in the liquid fraction of the soil.

**Inorganic Nitrogen – Ammonia (NH₃).** Ammonia is a transitional form of ammonium and easily volatizes into the air. The transition between ammonium and ammonia is affected by both pH and temperature. Fertilizer and manure application practices, cultivation, irrigation, and drainage can all affect ammonia movement.

**Inorganic Nitrogen – Nitrate (NO₃⁻) and Nitrite (NO₂⁻).** Nitrate is also a common form of inorganic nitrogen found in soil, fertilizer, manure and compost. Nitrate does not generally bind to soil particles and is therefore prone to leaching. This is particularly true in areas such as the Lower Mainland where mild temperatures, intense rainfall events and wet winters promote the formation and movement of nitrate through the soil. Nitrate leaching also occurs readily in coarse textured soils that receive high rates of irrigation. The leaching of nitrates into domestic water sources is a significant health concern. Nitrite is an unstable transitional form of nitrate. Both nitrates and nitrites can be toxic to aquatic life.
Soil bacteria, under certain conditions, convert nitrate and nitrite to gaseous nitrogen or oxides of nitrogen, a process called denitrification. This conversion results in the movement of nitrogen from the soil to the air.

**Organic Nitrogen.** The largest pool of nitrogen in soils is in the form of organic nitrogen. As organic matter is broken down by bacteria and other soil organisms, the nitrogen is either converted to the two common inorganic forms of ammonia or nitrate or returned back to the nitrogen pool as new organic matter in the form of plant or soil microbial biomass.

Additions of manure, crop residue, compost and other organic nutrient sources can change the size of the pool of organic nitrogen held in the soil. In contrast, cultivation and other cultural practices cause oxidation of organic matter and will result in the loss of nitrogen from the pool.

**Organic Matter**

Soil organic matter refers to organic matter that has become part of the humus portion of the soil. It does not refer to plant residue or organic matter which is applied to or remains near the soil surface, and which may be recognizable. Soil organic matter is involved in nutrient cycling by supplying and holding nutrients. Soils high in organic matter are also more efficient in holding water. Soil organic matter levels change relatively slowly over time but are strongly influenced by farming activities and climate.

**Phosphorus (P)**

Phosphorus has a low potential to leach into ground water because it is normally strongly bound to soil particles. However, in coarse soils and in fields that have experienced repeated phosphorus fertilizer or manure applications over several years, the ability of soils to bind phosphorus can be low. Furthermore, phosphorus is bound more than two times as tightly in
Fraser Valley soils in comparison to Okanagan soils. Availability is very dependent on soil pH (refer to Figure 8.2, below) and the presence of mycorrhizal fungi. Aggressive tillage can destroy these valuable fungi resulting in a reduction of immediately available phosphorus. Cultivation can be of value, as it aerates and warms the soil resulting in decomposition of organic matter and the release of organic phosphorus.

**Potassium (K)**

Potassium leaches very slowly, and is therefore subject to build up in soils. Soil that regularly receives manure is rarely deficient in this nutrient.

**pH**

pH is a measure of the acidity or alkalinity of a soil. Soil pH has a significant impact on the availability of plant nutrients and metals, and on the activity of soil microorganisms. It also affects the decomposition rate of organic-based soil amendments such as manure. The impact of pH on nutrient availability varies with the type of soil with the optimum for mineral soils ranging from 6.0 to 7.0 and for organic soils between 5.0 and 6.0. Optimum soil pH for specific crops may fall outside of these ranges. Figure 8.2, below, shows the effect of pH on the availability of nutrients in both types of soil.

As pH drops, the availability of many metals increases. A low pH can create a toxic metal environment within the soil that can impact plants negatively or can cause the metals to be more susceptible to leaching. As pH rises to levels above neutral (about 7.5), certain nutrients such as boron become less available to plants.

![Figure 8.2  Effect of pH on Availability of Nutrients in Soil](image)

**Salts**

Soluble salts in soil, which can impact crops, are measured by electrical conductivity (i.e., EC in units of dS/m). Crop species and varieties vary with respect to the levels of salts that they can tolerate. When the electrical conductivity of soils is above 2 dS/m they are considered to be salt affected. Crops are generally broken into three sensitivity groupings based on how well...
they perform for given ranges of salt concentration: sensitive (0 to 4 dS/m),
high tolerance (4 to 8 dS/m), and very high tolerance (greater than 8 dS/m).
Soils above 4 dS/m are said to be saline and will begin to cause a reduction in
the yield potential of a wide range of crops.

Salt impacts on soil are measured by the sodium adsorption ratio (SAR).
When the sodium adsorption ratio exceeds 13, soil structure is generally
degraded, evidenced by a hard cloddy or crusted surface and reduced water
infiltration due to loss of soil particle aggregation. In addition, sodium levels
begin to become toxic to plants. Farms in the Interior of BC should be aware
of the sodium adsorption ratio levels of their soils, and irrigation water when
used on susceptible fields.

**Secondary Nutrients and Micronutrients**

- **Calcium (Ca).** Calcium is an essential part of plant cell wall formation.
  Calcium is not readily mobile and is very important in soil structure
  formation.

- **Magnesium (Mg).** Magnesium is essential to the formation of the
  chlorophyll molecule in plants. Magnesium is not readily mobile in soils.

- **Sulphur (S).** Sulphur (also spelled as sulfur) is absorbed by plants in the
  sulphate ($SO_4^{2-}$) form, much the same way as nitrogen is absorbed as nitrate
  ($NO_3^-$). Like nitrate, the plant-available form of sulphur is released by
decomposition of organic matter by soil microbes. Traditionally, sulphur has
been considered to be mobile like nitrate. However, sulphur binding can
occur in acidic soils such as in Lower Fraser Valley. In these cases it behaves
like phosphorus in the soil.

- **Micronutrients.** These include elements like boron (B), copper (Cu) and
  zinc (Zn). They are required for enzymes and other substances in plants that
  regulate important functions like photosynthesis, growth and respiration. In
  general, the range between deficiency and toxicity is narrow; meaning the
  potential for toxicity to plants (and other organisms) is quite real.

**Soil Texture and Structure**

Soil texture is the relative proportion of sand, silt and clay and cannot be
easily changed. Soil structure is the arrangement of the particles or aggregates
in soil and can be slowly changed by soil practices, such as cultivation,
amendment additions, type of crops grown, and water management.
SOIL MANAGEMENT

Soil is a receiving environment just as air and water are. Good soil management promotes healthy plant growth, overall crop quality, and high productivity while preserving soil health. Productive soil depends on the appropriate integration of various field practices such as management of water, crop tillage and nutrient application. Excess water or nutrients will not only create problems associated with crop quality and yield, but will cause environmental degradation as well.

SOIL MANAGEMENT ENVIRONMENTAL CONCERNS

Primary environmental concerns related to soil management are:
- soil loss through erosion by water or wind that results in air or water pollution
- excess soil removal with harvested crops such as turf grass, nursery plants, and field vegetables, that results in loss of topsoil and eventual reduced crop yield
- soil compaction or structure degradation that results in decreased crop yield and increased runoff
- excess application of nutrients, micronutrients, metals and contaminants that results in soil or water pollution

For detailed information on these concerns:
- see Soil Quality Factors, page 8-1, and refer to Compaction, and to Contaminants
- see Water Quality and Quantity Factors, page 9-2, and refer to Contaminants, and to Overland Flow
- see Air Quality Factors, page 10-1, and refer to Contaminants

SOIL MANAGEMENT LEGISLATION

The following is a brief outline of the main legislation that applies to soil management.
- see page A-1 for a summary of these and other Acts and Regulations

Agricultural Land Commission Act

This Act requires agricultural land within an Agricultural Land Reserve to not be used for non-farm use unless permitted by the Act or its regulations. The removal of soil and placement of fill are deemed to be non-farm uses except as provided in Agricultural Land Reserve Use, Subdivision and Procedures Regulation.
Environmental Management Act

This Act allows emissions into the air of soil particulates or grit from soil management practices. It also has sections concerning contaminated soil:

- Section 55: requires agreement before contaminated soil can be relocated

The Code under the Agricultural Waste Control Regulation lists six specific requirements regarding application of agricultural wastes to soil such as manure, compost, vegetation:

- Section 3: must be collected, stored, handled, used, and disposed of in a manner that prevents pollution
- Section 11: must not be directly discharged into a watercourse or ground water
- Section 12: must be applied to land only as a fertilizer or a soil conditioner
- Section 13: must not be applied to land if runoff or the escape of agricultural waste causes pollution of a watercourse or ground water
- Section 14: must not be applied on frozen ground, in diverting winds, on areas having standing water, on saturated soils or at rates of application that exceed the amount required for crop growth, if runoff or escape of agricultural wastes causes pollution of a watercourse or ground water, or goes beyond the farm boundary
- Section 30: agricultural products must be managed, used, and stored in a manner that prevents the escape of agricultural waste that causes pollution

Wildlife Act

The provincial Wildlife Act protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

Fisheries Act

This Act has three sections of importance to soil management concerns:

- Section 35: prohibits harmful alteration, disruption, or destruction of fish habitat unless authorized
- Section 36(3): prohibits the deposition of deleterious substances into watercourses (deleterious substance could include soil sediments that erode from farmland)
- Section 38(4): requires reporting infractions of Sections 35 or 36

Species at Risk Act

This Act has sections that protect listed species, their residence, and critical habitat. It applies to federal lands, internal waters (i.e., all watercourses), territorial sea of Canada, and the air space above them.

The provisions of the Species at Risk Act (known as the ‘safety net’) could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.
Comply with applicable soil related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

**Soil Cultivation**

Cultivation plays a critical role in crop management and environmental protection. Implement the following practices:

- to reduce the risk of erosion and compaction, cultivate fields only when testing has shown that soils are at the correct moisture content, such that when soil is squeezed by hand
  - soils should be dry enough to easily crumble
  - if too dry, they will be either very hard or very powdery
  - if too wet, they will smear
- cultivate fields if the chance of significant rain in the forecast that could cause erosion is not expected
- cultivate to incorporate nutrients in order to
  - maximize nutrient retention
  - improve infiltration and thereby reduce the risk of runoff flow
- cultivate prior to liquid manure application to
  - break macro pores which can lead to direct discharge of manure to subsurface drainage tiles (macropores are formed by soil cracks, worm holes and mouse or mole holes)
- cultivate for weed control to
  - maximize crop yield and crop nutrient use by reducing competition
  - effectiveness is dependent on timeliness, since even small weeds can cause significant crop growth reduction
- cultivate after harvest to
  - incorporate crop residue if the risk of being carried off by wind or runoff is present
  - incorporate cover crop seed
  - break traffic or cultivation pans for improved water infiltration
- time cultivation for renovation of perennial forages to
  - minimize risk of erosion
  - minimize nutrient loss
  - maximize germination and crop cover
- cultivate the subsoil to improve aeration, to remove compacted layers and to improve water management for
  - better crop growth and nutrient use
  - increased infiltration of water

**Precautions.** Consider the following precautions when cultivating:

- do not over-cultivate since soil with reduced structure will have an increased risk of soil erosion
- do not use a conventional rototiller for repeated cultivation, residue incorporation and/or weed control since too much cultivation with a rototiller will pulverize the soil andcompact the subsoil over time
establish and maintain adequate buffers between cultivated fields and sensitive areas to keep soil erosion and dust from causing a nuisance or pollution → see Buffers, page 11-4

**Soil Erosion Risk**

Erosion refers to the loss of soil due to water or wind. Erosion risk depends not only on management practices, but on the topography and climate of a region. Water erosion can be the result of surface runoff caused by rapid snowmelt, heavy rainfall or excessive irrigation. Wind erosion occurs if soils are allowed to remain bare for extended periods of time. Wind and water erosion can both lead to loss of soil productivity and environmental problems. Eroded soil nutrients or fine-grained materials, such as silt or clay, can impact watercourses. Wind-blown soil can also cause dust nuisance and respiratory health problems. Wind-blown sand in particular causes physical damage to stems and leaves. The damaged plants are then susceptible to diseases, fungi and other pests.

The susceptibility of a site to soil erosion depends on several factors, some of which apply to both wind and water, and others to wind or water alone. The following list may help to assess the site for its erosion risk.

**Soil Texture and Structure.** Soil texture and structure play a role in both wind and water erosion. Fine textured soils such as very fine sand, silt and silt loam are highly susceptible to erosion. Soils with good structure (arrangement and stability of soil particles and pores) are more resistant to erosion than are individual particles. Organic matter helps to create good structure, with the result that soils high in organic content are more resistant to erosion.

**Soil Condition.** Saturated or compacted soil conditions facilitate erosion because excess water will flow over the soil surface rather than seep into the ground. Similarly, very dry soil conditions create an environment where wind erosion is more probable.

**Topography.** Topographic conditions play a major role in whether a site is prone to water erosion. In general, the greater the slope, the greater the risk that erosion may occur. Erosion increases at a rate of more than 2.5 times for each two fold increase in slope. Slopes of greater than 5% are considered to present a moderate risk of soil loss if left bare, while slopes of more than 10% are considered to have high risk of eroding. Erosion increases by 1.5 times for each two fold increase in slope length. If slopes are longer than 100 m, the erosion risk is considered high.

**Rainfall Intensity.** Sites subject to high-intensity, short-duration rainfall events or subject to rapid snowmelt runoff over frozen soils require extra management to prevent severe erosion.

**Wind Exposure.** Winds with sufficient velocity and of high frequency can contribute to the movement of significant amounts of soil if low soil moisture is coupled with the absence of surface cover or wind barriers.

**Surface Cover.** Bare and exposed soils increase both water and wind erosion potential. Bare soils are susceptible to a 100 fold increase in erosion potential when compared with grass-covered soils.
**Orientation of Rows.** Crop rows that are planted up and down slopes facilitate the overland flow of water and therefore promote soil erosion. Similarly, crop rows planted in the direction of prevailing winds promote wind channeling effects that increases erosive forces.

**Detailed Assessment of Erosion Risk.** Producers who wish to do a more complete water and wind erosion risk assessment on their sites can use a tool known as the Revised Universal Soil Loss Equation (RUSLE). This is a mathematical equation that predicts annual soil loss.

[The RUSLEFAC - Revised Universal Soil Loss Equation for Application in Canada]

**Field Soil Erosion by Water**

The potential for soil erosion due to runoff flow varies between operations depending on the risk factors discussed above. To reduce the erosion potential implement the following practices:

- establish cover crops or maintain crop residue between plant rows, along headlands, and on fields during non-cropping periods to reduce the destructive impact of rain drops – refer to Figure 8.3, next page
  - maintain a suggested minimum 30% to 50% cover crop foliage on the soil surface during high rainfall or runoff periods
- plant crop rows along contours instead of up and down slopes to slow and filter runoff flow
- install and manage drainage systems to maintain unsaturated soil conditions
- if cover crops are impractical or result in too much competition for water, cover the soil with organic mulches such as straw
- establish and maintain adequate vegetated buffers between fields and watercourses to protect ditch and stream banks, and to filter and slow down runoff flow  see Buffers, page 11-4
- modify tillage practices to keep crop residue on the surface for greatly reduced erosion potential
  - practice conservation tillage in all regions of the province
  - maintain a suggested minimum of 30% to 50% anchored cover crop residue on the soil surface when crops are not growing
- use grassed waterways, drop structures, lined channels or terraces to control more severe water erosion problems (technical advice may be needed to implement some of these special measures)
Minimizing the Effects of Runoff Flow. Runoff flow results from rainfall events, snowmelt or excess irrigation water. Controlling rainfall-generated stormwater on the farm can be a critical factor in reducing soil erosion in areas around buildings, yards, roadways, ditches and fields. Uncontrolled stormwater flow is very erosive to soil, as it tends to be high in intensity and short in duration. Such flow readily carries soil, crop residue and agricultural waste by virtue of its high velocity and turbulence.

Stormwater from roofs should be collected and diverted into ponds or grassed waterways. Stormwater from roadways and yards should be collected and filtered to remove suspended solids, nutrients and other contaminants. Clean water can be diverted directly into drainage systems if they have been designed to handle the peak flows characteristic of stormwater events.

The interception of surface and subsurface flow from adjacent properties can reduce soil erosion. Drain areas on hillsides with shallow soils overlying compact subsoil, or areas subject to saturation, with tile lines placed across the slope and backfilled with a porous medium. Use porous interceptors, also known as French drains, to capture runoff. Maintain the land surface above such drains in a porous, open condition by establishing permanent vegetation directly over the drain line or by growing a winter cover crop.

Grassed Waterways. Grassed waterways are designed to collect and transport water from fields while protecting the soil from the erosive force of rapidly-moving concentrated water flow. Grassed waterways may be integrated into fields from which forage may be directly harvested; however, they are usually designed to contain different species, and are subject to different management practices than the rest of the field.
Soil Erosion Along Watercourses

Soil erosion along watercourses often occurs when the vegetation surrounding the watercourse, known as the riparian area, is in poor condition. Healthy riparian areas are critical in protecting stream banks, and by extension farmland, from erosion. Well-vegetated riparian areas have a root mass that binds the soil together for good erosion resistance. If a watercourse starts eroding, especially if water flow volumes and velocities are high, soil loss can be dramatic and every difficult to stop. >> see Riparian Areas, page 11-13

Field Soil Erosion by Wind

Susceptibility to wind erosion is greatest when the ground is bare, when plants are young, or when land is unprotected from the effects of wind. Options for the control of wind erosion include reduced tillage, strip cropping, crop residue cover, mulches, windbreaks, shelterbelts, and wind barriers such as fences.

Strip Cropping. This management-intensive practice involves planting strips of crops with varying growth characteristics (e.g., alternate rows of grain and forage).

Cover Crops. Cover crops are useful for protecting the soil surface from erosion by wind. The taller and denser the crop, the better protected will be the soil. Planting cover crops provides additional benefits such as tying up nutrients until productive crops can utilize them. Most soils require a minimum 30% ground cover to prevent wind erosion. This means that choice of species, seeding rates, and planting dates are critical for cover crops to be effective. Suitable cover crops for early summer planting are cereal/legume mixes or annual ryegrass. Appropriate cover crops to follow late harvested annual crops include fall rye, winter wheat or winter barley.

Fences. Fences can provide protection from wind erosion where vegetative windbreaks are impractical.  
>> B.C. Agricultural Fencing Handbook (series of Factsheets)

Mulches. The most effective mulches to reduce or control wind erosion are straw, coarse wood chips or larger pieces of crop residue. In order to be an effective erosion control practice the mulch must be anchored.

Crop Residue Cover. Crop residue left on the fields after harvest also provides erosion protection. To be effective, at least 30% of the soil surface needs to be covered by residue. Crop residue protects soil from wind erosion by reducing wind speeds at the soil surface. Residues can take the form of standing stubble or post harvest crop waste. In the case of cereal crops, a 30% cover is equivalent to about 1,300 to 1,700 kg/ha of residue. Highly erodible soils may require double this amount of residue to effectively reduce erosion.  
>> Estimating Crop Residue Cover for Soil Erosion Control

Reduced Tillage. The risk of both wind and water erosion is decreased by reduced tillage practices. These include minimizing or eliminating cultivated fallow, decreasing the number of tillage events, and choosing implements and methods that minimize soil and residue disturbance.

Protecting Pastures. Overgrazing reduces long-term pasture productivity and leaves soil prone to erosion. Manage grazing to leave adequate plant cover at all times.
Windbreaks. Establish and maintain adequate vegetative buffers in strategic locations around the farm to minimize soil erosion by wind and to prevent dust from creating a nuisance or causing pollution. ➔ see Buffers, page 11-4

Soil Loss by Harvest

The degree of soil loss caused by certain harvest practices is dependent on the type of crop grown and the soil moisture conditions at harvest. Harvesting of balled and burlapped nursery stock, turf, and field vegetable crops commonly remove soil from fields. In the case of field vegetables, most of this soil remains on the farm after crop washing and eventually should be returned to the field. In cases where soil loss is unavoidable, rebuild the soil by adding amendments, such as sand, and by implementing practices that improve soil organic matter content such as cover cropping.

➔ see Chapter 6, Soil Amendments

The following practices are recommended to reduce soil loss.

Field-Grown Nursery Stock. Prune roots, use large pot sizes when planting out stock, market bare root plants in place of ball & burlapped when possible, and avoid wet soils during harvest.

Turf Nursery. Reduce the depth of cut, use ground netting, and avoid wet soils during harvest.

Field Vegetables. Avoid cultivation activities on west soils which causes clodding. Avoid harvesting in wet soils. Use soil eliminators on mechanised harvesting equipment.

Nutrient Management

Nutrient requirements are likely to be different for each field and crop. It is important to understand specific nutrient requirements in order to prevent the waste of nutrients and in order to minimize the risk of pollution. This is best accomplished by following a nutrient management plan.

➔ Nutrient Management Reference Guide

Nutrient management requires the balancing of nutrients taken up by a crop with those supplied by both the soil and other sources. For effective nutrient management planning, check soil nitrogen, phosphorus and potassium levels yearly for annual crops and every third year for perennial crops. Check soil levels for micronutrients and metals every three to six years. ➔ see Chapter 6, Soil Amendments, for general information on nutrient management

Leachate Formation in Soil

Leaching is the removal or transfer of soluble compounds by water from soils or other materials such as manure, silage, compost or woodwaste which have been incorporated into or placed on the soil. The primary concern is the potential for leachate nutrients or metals reaching surface or ground water.

➔ see Leachate, page 9-48 for information on leachate management

Leaching of metals from soils occurs when soil pH decreases, causing metals in the soil to become more soluble, contributing to a greater risk of toxic leachate formation. In order to reduce the risk of leachate generation containing metals, implement the following practices:

♦ know the effect of various soil amendments and mulches on soil pH and maintain soil pH above 4.5
Contaminant Movement in Soil

- woodwaste added to soil will lower soil pH

➤ see Woodwaste, page 2-27

The movement of water with contaminants in soil, such as petroleum, nutrients, pesticides or leachate, is affected by:

- the amount of water moving through the soil, such as from rainfall, irrigation or runoff
- the infiltration and permeability of the soil
- the ability of the soil to bind contaminants

The rate at which contaminants on the soil surface enter the soil is controlled by the soil’s infiltration rate. Permeability is a measure of the rate at which water moves through the soil. The size and continuity of soil pores control both permeability and infiltration. Factors which influence infiltration and permeability are shown in Table 8.1, next page.

The soil’s ability to bind contaminants depends on soil texture and organic matter content. Coarse-textured soils (have a high percentage of sand), display a low ability to bind contaminants, while fine-textured soils (or clays), display a high ability to bind contaminants. The higher the organic matter component in a soil, the greater is its ability to bind contaminants.

Risk of contaminant movement into soils (infiltration) and though soils (percolation) are governed by a range of characteristics. Each characteristic may impart a high or low risk depending on the management of the site. For example a clay soil with large pores or cracks will have a higher risk. If this same soil was compacted the risk would be lower. Soil texture and structure have the highest weighting with respect to level of risk. Structure can be modified by manipulating the soil or by the introduction of compacted organic layers, such as those that form in feedlots.

If the majority of the soil or site characteristics fall into one or the other risk category the soil should be classed within that category. Animal density and contaminant characteristics will also impact the risk of movement. There is an inverse relationship between risk of leachate and risks of runoff. Soils with a low risk of contaminant (leachate) movement generally contribute to a higher risk of runoff. Soils with a high risk of contaminant (leachate) movement are generally most desirable for cropping.
### Table 8.1 Risk of Contaminant Movement through Soil

<table>
<thead>
<tr>
<th>Infiltration and Permeability Factors</th>
<th><strong>Soils with High Risk</strong>&lt;sup&gt;b&lt;/sup&gt; of contaminant movement have these typical characteristics</th>
<th><strong>Soils with Low Risk</strong>&lt;sup&gt;c&lt;/sup&gt; of contaminant movement have these typical characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Soil Texture</strong></td>
<td>- coarse textured sandy or gravelly</td>
<td>- fine textured silty or clay</td>
</tr>
<tr>
<td></td>
<td>- dry cracked clay soil</td>
<td>- greater than 15% clay</td>
</tr>
<tr>
<td></td>
<td>- organic soils</td>
<td>- homogeneous texture throughout the profile</td>
</tr>
<tr>
<td><strong>Soil Structure/Pores</strong></td>
<td>- well structured, blocky or large crumbs with large or abundant pores (macropores)</td>
<td>- poorly structured, platey or smeared with few or fine pores (micropores)</td>
</tr>
<tr>
<td><strong>Soil Organic Matter Content</strong></td>
<td>- high organic matter content in well structured mineral soil - resulting in significant large pores - poorly decomposed organic soils</td>
<td>- low organic matter content in poorly structured mineral soil - muck or decomposed peat soils</td>
</tr>
<tr>
<td><strong>Soil Density</strong></td>
<td>- loose, easily broken into small lumps</td>
<td>- dense, compacted or cemented</td>
</tr>
<tr>
<td><strong>Animals</strong></td>
<td>- abundant soil animals or burrowing insects</td>
<td>- soil animal or burrowing insects channels are absent</td>
</tr>
<tr>
<td><strong>Roots</strong></td>
<td>- abundant coarse roots and root channels</td>
<td>- few root channels and many fine roots</td>
</tr>
<tr>
<td><strong>Soil Depth</strong></td>
<td>- shallow soils over gravel or fractured bedrock</td>
<td>- deep, well defined topsoil and subsoil over slowly pervious rock or clay</td>
</tr>
</tbody>
</table>

<sup>a</sup> Contaminants, such as manure, pesticides, petroleum, leachate, etc.  
<sup>b</sup> High Risk of contaminant movement = infiltration more than 10 mm/hr & permeability more than 1.2 m/day  
<sup>c</sup> Low Risk of contaminant movement = infiltration less than 5 mm/hr & permeability less than 0.04 m/day  

Note - there is an inverse relationship between risk of leachate and risks of runoff:  
- soils with a low risk of contaminant (leachate) movement generally contribute to a higher risk of runoff  
- soils with a high risk of contaminant (leachate) movement are generally most desirable for cropping

### Soil Contamination

Contaminants may include non-organic compounds (e.g., salts, metals, pesticides, excessive nutrients) and organic compounds (e.g., hydrocarbons, oils, dioxins, furans, weed seeds, pathogenic organisms). To prevent soil contamination it is necessary to know the chemical characteristics of all materials used on the farm, including pesticides, fertilizers, manure, compost and other soil amendments. Off-farm organic materials must be fully identified before use as well. Numerous beneficial off-farm organics are identified in Schedule 12 of the *Organic Matter Recycling Regulation*.

Implement the following practices to monitor and prevent soil contamination.

- see Farm Waste, page 2-13
- see Petroleum, page 2-22
- see Pesticides, page 5-14
- see Chapter 6, Soil Amendments, page 6-4

Use Caution When Bringing Non-Agricultural Waste or Products on to Your Farm!

If contamination is suspected or does occur, consult MOE and a qualified environmental professional for remediation procedures.
pH Check. pH levels in soil may be affected by application of soil amendments or cultivation. Implement the following practice:

♦ check pH levels every three to six years, or more frequently if soil pH levels are suspected of restricting crop growth and adjust pH in the soil as required

♦ when soil pH is lower than 5.5 or higher than 7.5 on mineral soils special management is required to adjust pH, such as liming or acidifying the soil

Salt Check. Salt levels in soil may be affected by application of farm nutrients, chemical fertilizers, or irrigation water. Monitor the salt level by measuring electrical conductivity (EC) and sodium adsorption ratio (SAR) on a regular basis. Implement the following practices:

♦ check electrical conductivity every three to six years, or more frequently if soil salts are suspected of restricting crop growth

♦ in the Interior of BC, check the sodium adsorption ratio of the soil every three to six years, or more frequently if levels are suspected of negatively affecting soil structure

♦ reduce salt and sodium levels in soil amendments as required

♦ check irrigation water quality ➔ see Irrigation Water Quality, page 9-20

If salt levels within the soil are found to be high (when soil salt level exceeds 2 dS/m or when the sodium adsorption ratio exceeds 5), and if leached salts have been determined to not cause an environmental impact:

♦ remove the salt from the crop root zone by applying irrigation water at a rate that causes leaching to occur and/or improve drainage

♦ if the sodium adsorption ratio is found to be high, apply gypsum to the soil prior to applying water to cause leaching

Micronutrients and Metals Check. Micronutrient and metal levels in soil may be affected by the application of farm nutrients or chemical fertilizers. Implement the following practices:

♦ check concentrations of micronutrients and metals in both soils and soil amendments
  • in soils every three to six years, or more frequently if the soil tests indicate levels greater than soil limits shown in Table 8.2, next page
  • in manure every three to six years, or more frequently if the manure tests indicate levels greater than organic nutrient limits shown in Table 8.2, next page

♦ reduce metal levels in farm nutrient sources as required by
  • changing to feeds with lower metal levels
  • altering soil pH to reduce metal uptake in crops

♦ reduce metal build-up in soil where required by moving manure applications to fields with low metal levels
### Table 8.2 Suggested Concentration Limits of Metals in Nutrient Sources and Soils

<table>
<thead>
<tr>
<th>Metal</th>
<th>Organic Nutrient Limit 1 (total μg/g dry weight)</th>
<th>Soil Limit 2 (total μg/g dry weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Symbol</td>
<td></td>
</tr>
<tr>
<td>Arsenic</td>
<td>(As)</td>
<td>13</td>
</tr>
<tr>
<td>Cadmium</td>
<td>(Cd)</td>
<td>3</td>
</tr>
<tr>
<td>Chromium</td>
<td>(Cr)</td>
<td>100</td>
</tr>
<tr>
<td>Cobalt</td>
<td>(Co)</td>
<td>34</td>
</tr>
<tr>
<td>Copper</td>
<td>(Cu)</td>
<td>400</td>
</tr>
<tr>
<td>Lead</td>
<td>(Pb)</td>
<td>150</td>
</tr>
<tr>
<td>Mercury</td>
<td>(Hg)</td>
<td>2</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>(Mo)</td>
<td>62</td>
</tr>
<tr>
<td>Nickel</td>
<td>(Ni)</td>
<td>2</td>
</tr>
<tr>
<td>Selenium</td>
<td>(Se)</td>
<td>2</td>
</tr>
<tr>
<td>Zinc</td>
<td>(Zn)</td>
<td>500</td>
</tr>
</tbody>
</table>

1. Organic nutrient source limit (Class A Compost) from *Organic Matter Recycling Regulation, Schedule 4*
2. Soil limit from *Organic Matter Recycling Regulation, Schedules 9 and 10 (Agricultural Land)*
3. 1 μg/g is one part per million, or 1 ppm
4. Specific soil standards for environmental protection based on livestock ingesting soil and fodder.
5. Specific soil standard for Chromium +6
6. Recommend lowering the standard to 40 μg/g for land which sheep are grazing and 150 μg/g for all other livestock

---

### Soil Compaction

Soil compaction reduces pore spaces between soil particles, resulting in decreased air and water movement through the soil, deteriorated drainage conditions, and slower warming of the soil. The effects of severe soil compaction on crops include insufficient nutrient uptake, root damage and premature aging. Environmental concerns caused by compaction are the excessive runoff flow due to the low infiltration rate of compacted soil and the associated discharge of nutrients to watercourses.

Compaction is often caused by the operation of heavy machinery on wet soils and by inappropriate tillage techniques, such as those producing plough-panns. Excessive tillage breaks soil aggregates, disrupts structure, and encourages quick decomposition of organic matter, all leading to a low organic matter content. The resulting low organic matter, in turn, contributes to the soil being even more susceptible to compaction.

In order to determine if compaction is present, check for soil layers, including thin crusts near the surface, which restrict root or water movement by examining the sides of a constructed soil pit.

### Surface Soil Compaction

It is difficult to reverse surface soil compaction. Freeze-thaw cycles, root activity, and soil animal activity are not sufficient to overcome annual compaction events. To prevent surface soil compaction, implement the following practices:

- avoid working with equipment on wet soils
- keep livestock off wet soils
- ensure that fields are well drained during the growing season
- reduce the number of trips over a field with equipment
- minimize tillage, particularly operations which pulverize the soil

---

8-18 *BC Environmental Farm Plan: Reference Guide*
use a wide variety of tillage implements including chisel ploughs or subsoilers, and vary tillage depth
- limit the weight on an individual axle to below five tonnes
- install flotation or radial tires on equipment to better distribute weight
- use four-wheel-drive tractors for better weight distribution between axles
- limit equipment and foot traffic to the same areas in a field (e.g., establish lanes and roadways)
- employ good crop rotation practices with deep-rooted crops and cover crops
- delay entry into fields until the watertable is 50 cm (suggested) below the soil surface
  - in coastal regions, no field work should occur until 48 hours after a 50 mm/24 hour rainfall event has passed

Subsoil Compaction. Compaction of soils below the plow layer is more difficult to deal with than surface compaction. To prevent subsoil compaction, implement the following practices:
- follow the steps outlined above for preventing surface soil compaction
- work soils only if they are dry within the tillage zone
- plant deep-rooted cover crops
- use a crop rotation program
- install a subsurface drainage system

If subsoil compaction has occurred, subsoilers may provide some relief. However, this equipment may create other problems such as unwanted root pruning or increased compaction at the working level if the soil is too wet. Only use subsoiling equipment when the soil below the normal tillage layer is dry enough to fracture rather than smear.

Soil Organic Matter Content

Soil organic matter is generated from the decomposition of crop residue and other organic materials. Soil organisms and microorganisms digest plant residues to form humus, the earthy, dark coloured material, often associated with topsoil. Humus breaks down very slowly, and provides fertility to the soil. In addition it binds mineral soil particles together, resulting in increased stability when the soil is wetted or cultivated. The impact of higher levels of organic matter in the soil not only improves soil fertility, but contributes to soil structure and plant vitality by:
- holding essential nutrients for plant growth
- increasing resistance to erosion, crusting and compaction
- facilitating water and air movement through the soil
- increasing water retention capacity
- improving conditions for beneficial soil microbes

Maintaining a high organic matter content in soils may reduce the amount of irrigation water, fertilizers and pesticides required. Soils with higher organic matter content are generally characterized by better tilth and are therefore less susceptible to damage caused by improper tillage.

Cover Crops. Increasing the organic content of a soil by utilizing a "green manure" requires the growing of a legume or grass crop for deliberate incorporation into the soil before seeding or planting a new cash crop.
Mulches. Mulches are generally recognized as a tool for soil moisture conservation, weed suppression and soil temperature modification. Suitable mulch materials include straw, leaves, hay, grass clippings, crop residues, compost and woodwaste. Mulch depths range from 2 to 10 cm. Mulches will decay over time and become part of the stable organic matter pool in soil. If high carbon-nitrogen ratios mulches, such as straw or woodwaste, are incorporated by cultivation the amount of available nitrogen in the soil may be reduced.

Woodwaste. Woodwaste can be used as a soil conditioner to increase organic matter levels. Fine particle sized material or material that has been partially decomposed or composted is most appropriate. The amount of woodwaste incorporated into the soil should not raise the carbon-nitrogen ratio above 50. If the carbon-nitrogen ratio is taken above this level, available nitrogen will be tied-up for 2 to 3 years. The nitrogen will be released over time as the woodwaste continues to decompose.

Compost. Fully composted organic wastes are an excellent source of organic matter but typically supply limited amounts of crop nutrients. Both timing of application and the nutrient content of the material are important considerations for compost application. Compost generally has a lower nutrient content than manure. In addition, the nutrients from composted materials are released at lower rates than is the case for manure. However, in some cases composted manure can have high nitrogen content that is rapidly released when applied to soil.

Composts have less impact on the nitrogen content of the soil than other raw organic materials such as mulches. Composts with a carbon-nitrogen ratio of between 10 and 20 will not adversely affect the soil-available nitrogen content. High application rates of compost should be coupled with a cover-cropping program to prevent excess nutrients from leaving the soil profile.

Livestock Manure. Manure may be utilized as a source of organic matter; however, do not apply at rates higher than required for its fertilizer value. If manure is used as an organic amendment it is recommended that its use be in conjunction with a cover cropping program to trap excess nutrients.

Organic Soil Subsidence

Organic soil subsidence is the loss of organic material through erosion or decomposition. Subsidence can be prevented through effective water management, cultivation practices, nutrient management, and cropping.

An effective water management program will balance the drainage required to provide soil strength and aeration, with the supply of sufficient water to both promote crop growth and minimize organic soil decomposition. Maintain waterlogged soil conditions to retard decomposition of some organic soils. Use caution when flooding organic soils, particularly muck soils that are highly decomposed or soil with shallow organic layers. Flooding can create restrictive layers near the surface that reduce the effectiveness of drainage systems. Drainage systems in wetland areas should be managed to regulate water table levels in response to changing crop and habitat requirements.
not allow organic soils to dry out since excessive drying may discourage re-wetting and may result in the loss of the surface layers from erosion.

Avoid tillage practices that pulverize and leave organic soils exposed to air as this promotes rapid decomposition. Use minimum tillage practices for all organic soils.
## CHAPTER 9  METRIC CONVERSIONS

<table>
<thead>
<tr>
<th>Metric</th>
<th>Imperial Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.54 mm</td>
<td>1/10 inch</td>
</tr>
<tr>
<td>25 mm</td>
<td>1 inch</td>
</tr>
<tr>
<td>50 mm</td>
<td>2 inch</td>
</tr>
<tr>
<td>30 cm</td>
<td>12 inch</td>
</tr>
<tr>
<td>0.3 m</td>
<td>12 inch</td>
</tr>
<tr>
<td>15 m</td>
<td>50 feet</td>
</tr>
<tr>
<td>30 m</td>
<td>100 feet</td>
</tr>
<tr>
<td>30.5 m</td>
<td>100 feet</td>
</tr>
<tr>
<td>60 m</td>
<td>200 feet</td>
</tr>
<tr>
<td>100 ml</td>
<td>3.3 oz (US liquid)</td>
</tr>
<tr>
<td>1 mg/litre</td>
<td>1 ppm</td>
</tr>
<tr>
<td>10 mg/litre</td>
<td>10 ppm</td>
</tr>
<tr>
<td>100 mg/litre</td>
<td>100 ppm</td>
</tr>
<tr>
<td>1 ha</td>
<td>2.47 acre</td>
</tr>
</tbody>
</table>

Conversions in this table are rounded to a convenient number.  
See Appendix E for exact conversion factor.  
Values from tables and examples are not included in Metric Conversions.
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9 WATER

INTRODUCTION

This chapter discusses water management practices for protection of the environment. It contains introductory information on the relationship between agriculture and water quality and quantity. It also contains information on environmental concerns, legislation and beneficial management practices related to:

- water supply systems (domestic and livestock)
- irrigation
- drainage
- leachate
- storm water and runoff
- water conflicts

WATER QUALITY AND QUANTITY FACTORS

The primary water quality factors associated with potential environmental impacts for drinking water are contaminants. For fish and other aquatic life, the primary factors are water temperature, dissolved oxygen and contaminants. For water quantity, the primary factor is water withdrawal.

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The following water quality and quantity factors are listed alphabetically. While these factors can be influenced by agricultural production, they may also be influenced by many other human activities and natural phenomena.

Contaminants

**Total Ammonia.** Ammonia (NH₃) and ammonium (NH₄⁺) exist in urine, manure, fertilizer and compost. Contaminated runoff from fertilized cropland and uncovered manure or compost piles is characterized by a high total ammonia concentration. Water containing elevated levels of total ammonia may be toxic to fish and other aquatic life. Ammonia is more harmful to aquatic life when compared to ammonium. In the pH range of most natural waters, ammonia nitrogen will exist principally as ammonium.

**Micronutrients and Metals.** Specific metals of concern include arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc. Although trace quantities of some metals are necessary for life, even low metal concentrations are undesirable. Elevated metal concentrations can directly kill fish and other aquatic life or cause accumulation in tissues, making them unfit for human consumption. Some sources of metals include manure, waste oil,
hydraulic fluids and fertilizers. Woodwaste leachate, by virtue of its acidity, can increase the rate of metal release from soils as well.

**Nitrate (NO₃⁻).** The total ammonium nitrogen in manure or fertilizer converts to nitrate (NO₃⁻) form in soil. Because nitrate does not attach to soil particles as does the ammonium form, it is easily leached from the soil. Once out of the root zone, nitrates will continue moving to ground water and surface water.

Nitrates in ground water are often an early indication of contamination elsewhere. Elevated levels of nitrates in drinking water are a particular hazard for infants. The maximum allowable concentration of nitrates as recommended in the Guidelines for Canadian Drinking Water Quality is:

- 10 mg/litre of nitrate plus nitrite nitrogen (with not more than 1 mg/litre being nitrite nitrogen) for human consumption


The maximum allowable concentration of nitrates as recommended in the Canadian Water Quality Guidelines for the Protection of Agriculture Water uses is:

- 100 mg/litre total nitrate nitrogen (where nitrate and nitrite are determined separately, levels of nitrite should not exceed 10 mg/litre) for livestock consumption

[Canadian Water Quality Guidelines for the Protection of Agriculture Water Uses](http://ceqg-rcqe.ccme.ca/download/en/132/)

**Nutrients.** Elevated nutrient levels in watercourses can be caused by manure or fertilizer entering a watercourse directly, by contaminated water flowing from fertilized fields, or by nutrient-rich soil being eroded from croplands. Certain elements, especially nitrogen and phosphorus, accelerate eutrophication (nutrient enrichment of water bodies). Phosphorus is generally the limiting nutrient in lake systems (i.e., the addition of phosphorus alone will accelerate eutrophication); however, both nitrogen and phosphorus can be limiting in streams. The most common effects of eutrophication in surface waters are massive blooms of algae which result in depleted oxygen levels. Blue-green algae in sufficient quantities is toxic to livestock.

[Blue-Green Algal Blooms in Lakes](http://www.env.gov.bc.ca/wat/wq/BCguidelines/approved_wq_guide/approved.html)

**Pathogens.** Many organic wastes, including manures, contain microorganisms such as bacteria, viruses and other parasites. Some of these microorganisms may be pathogenic (disease causing) to animals of the same or different species. Many diseases are transmissible between animals and humans and water can be a pathway for the transmission of infection. Pathogen contamination of shellfish beds is not uncommon, rendering shellfish unfit for human consumption.
**Pesticides.** Pesticides, including fungicides, insecticides and herbicides hold great potential to pollute both surface and ground water. Water polluted by pesticides can be the result of application drift, leaching, erosion of contaminated soil, spills, and direct introduction. Pesticide-contaminated water can have harmful effects on aquatic life, animals and humans.

**Petroleum.** Petroleum, antifreeze, paints, solvents, hydraulic fluids and other oil-based substances can cause direct and indirect harmful effects on watercourses and ground water. Examples of adverse effects caused by petroleum products include acute toxicity to a variety of aquatic organisms and respiratory distress in fish. Waterfowl, amphibians and insects are sensitive to petroleum pollution as well.

Other negative impacts caused by petroleum products in water include the destruction of fish food organisms such as algae and other plankton, the smothering of fish spawning areas, the reduction in the rate of photosynthesis in plants and poor stream aeration. In addition, petroleum products can taint the flavour of aquatic food products.

**Solids.** Solids exist either in dissolved or suspended form in water. Both may include nutrients and metals, can elevate the biological oxygen demand of water, and cause long-term damage (refer to “Oxygen Demand”, next page). Some types of dissolved solids, such as ammonia, can be toxic to fish.

Suspended solids are larger in size than dissolved solids. Unlike dissolved solids, suspended solids can be removed by settling or filtering. Suspended solids are primarily silts and clays, but can also include oils, pathogens, woodwaste components, and other materials attached to particles in the water. Suspended solids in watercourses can clog the gills of fish, affect fish vision and, upon settling, fill in pore spaces between pebbles, thereby destroying spawning grounds or smothering the eggs of aquatic organisms.

Turbidity is a measure of the cloudiness of water. Turbidity may affect water treatment processes, reducing the appeal of drinking water or the effectiveness of wash water disinfection. As a result, higher levels of chlorine may need to be added to drinking water or wash water to achieve acceptable safety levels. High levels of chlorine are toxic to fish. Turbidity also blocks the sunlight required by photosynthesizing aquatic plants, resulting in decreases in fish food plant biomass and lowered oxygen levels in water. Ultra Violet disinfection of turbid wash water is less effective than disinfection by chlorination. Food safety may be compromised as a result.

**Woodwaste Leachate.** Woodwaste (e.g., sawdust, shavings, chips, hog fuel, bark) can cause negative impacts on surface and ground water. Exposure to water, air and microorganisms will cause woodwaste to break down and release dissolved compounds. Some of these compounds, particularly tannins, tropolones and resin acids, are not only human health hazards, but are also acutely toxic to aquatic life.

Woodwaste leachate entering surface water also causes indirect effects. Reduced oxygen levels, due to high biological oxygen demand and chemical oxygen demand values, result in lower photosynthesis rates in aquatic plants. The colour of woodwaste leachate will also reduce light transmission and
thereby reduce photosynthesis. In addition, woodwaste leachate is acidic, facilitating the unwanted movement of metals and nutrients out of the soil and into receiving waters. (refer to Oxygen Demand, below)

**Contaminant Pathways**

**Infiltration.** Water movement into and through soils is governed by the permeability of the soil. Coarse textured soils or soils with large numbers of macro pores will have high infiltration and percolation rates. Rapid water movement through soil can lead to increased risk of leaching loss of nutrients or contaminants to ground water or subsurface drains.

**Overland Flow.** Farmstead buildings, roads and impermeable farmyards will intensify the effects of rainstorm events. Peak stormwater discharges to watercourses are increased whenever a high proportion of impermeable surfaces exist.

Overland water flow occurs either because the soil is saturated and unable to absorb more water or because water is applied at a rate greater than the soil can absorb. This can result in erosion or the movement of contaminants to surface water.

**Wells.** The direct entry of overland flow into ground water via poorly constructed wells or well casings is another potential contaminant pathway.

**Oxygen**

**Oxygen Demand.** High oxygen-demanding materials such as manure, silage, fruit, vegetables and composting juices use dissolved oxygen in water directly as they decompose. Increased nutrient levels in water can also indirectly cause high oxygen demand by encouraging the growth of aquatic organisms. After these organisms die, natural decay accelerates the depletion of oxygen to levels below that required by fish and aquatic life. The rate of oxygen depletion is measured as Biological Oxygen Demand (BOD).

**Dissolved Oxygen.** Dissolved oxygen is measured as a percentage of saturation. If wastes with high oxygen demand or high nutrient levels are allowed to enter watercourses, the result is a drop in dissolved oxygen levels. Reduced oxygen levels are harmful to fish and aquatic life.

**Temperature**

Elevated water temperature has direct and indirect impacts on water quality. As water temperature increases, its oxygen-holding capacity decreases. This will become harmful to fish and aquatic life. Watercourse temperature thresholds are set to protect fish. Indirectly, elevated water temperature contributes to the growth of aquatic organisms which accelerates the depletion of oxygen levels.

**Water Withdrawal**

The excessive removal of water for uses such as irrigation and livestock watering can result in the insufficient availability of water for fish food production, fish and fish habitat, wildlife abundance, and in elevated water temperatures. Also, reduced water levels will typically exacerbate water quality concerns and may increase the risk of fish predation due to easier access for predators.

Surface water withdrawals require screened intakes to protect fish. They are designed for opening size to prevent fish entry and for low water velocity across the screen to prevent fish loss from being drawn against the screen.
Withdrawal of surface water or ground water may impact users other than those taking direct advantage of the water. Licenses for surface water withdrawals are intended to prevent these conflicts. There is currently no provincial licensing for groundwater to protect against over withdrawal.
WATER SUPPLY ENVIRONMENTAL CONCERNS

Primary environmental concerns related to water supply systems are:

Water Quantity
- ground water withdrawals that result in
  - lowering of the water table
  - reduced ground water input to surface water
- surface water withdrawals causing low stream flows and velocities that result in impacts to fish and other water users

Water Quality
- cross connection of water supply lines to lines carrying contaminants that results in pollution of supply water
- poor well construction (e.g., lack of sealing), location (e.g., down gradient from contaminate source) or well abandonment, that results in ground water pollution
- disturbances to watercourses during installation of intakes that results in water pollution and habitat loss
- livestock access to watercourses that results in pollution of surface water, habitat disturbances, or trampling of stream banks

For information on these concerns:
- see Water Quality and Quantity Factors, page 9-1, and refer to all sections
- see Impacts to Biodiversity and Habitat, page 7-8, and refer to Farm Activities and Impacts

WATER SUPPLY LEGISLATION

The following is a brief outline of the main legislation that applies to farm water supply.
- see page A-1 for a summary of these and other Acts and Regulations

Local Bylaws
The BC Building Code has requirements for backflow prevention and is enforced only where proclaimed by local governments.
Drinking Water Protection Act

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).

♦ Section 6: requires water suppliers to provide potable water to water users
♦ Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system

The Drinking Water Protection Regulation defines potable water as “water from a domestic water system” that has the following characteristics:
♦ water that meets the standards prescribed by the regulation and that is safe to drink and fit for domestic purposes without further treatment.
♦ no detectable fecal coliform bacteria or Escherichia coli per 100 ml
♦ no detectable total coliform bacteria per 100 ml for a sample in 30 days
♦ at least 90% of samples have no detectable total coliform bacteria per 100 ml and no sample has more than 10 total coliform bacteria per 100 ml for more than one sample in 30 days
♦ having limits on chemical and physical parameters (such as nitrates and heavy metals)

Guidelines for Canadian Drinking Water Quality

Environmental Management Act

The Code under the Agricultural Waste Control Regulation allows for access to watercourses by livestock:
♦ Section 25: livestock in a grazing area may have access to watercourses provided that the agricultural wastes produced by that livestock does not cause pollution
♦ Section 27: livestock in a seasonal feeding area may have access to watercourses provided the access is located and maintained as necessary to prevent pollution

Fish Protection Act

The Fish Protection Act enables the protection of fish and fish habitats. Four main objectives of the Act are to ensure sufficient water for fish, enable fish habitat to be protected and restored, improve riparian habitat protection and enhancement, and to give local governments greater powers for environmental planning.
♦ Section 4: prohibits new dam construction on specified major rivers
♦ Section 6 and 7: allows designation of sensitive streams and recovery plans
  • such streams would have restrictions placed on new water licenses or approvals, or amendments to existing ones until the stream has recovered
♦ Section 9: In the case of drought, for the purposes of protecting the fish population, the minister may make temporary orders regulating the diversion, rate of diversion, time of diversion, storage, time of storage and use of water from the stream by holders of licences or approvals in relation to the stream.
Public Health Act: This Act has conditions under the Public Health Act Transitional Regulation:
- Section 18: provides separation distance of wells to be at least 30.5 m from any probable source of contamination

Water Act: This Act and Regulations licence surface water and protects ground water:
- Section 2: vests property and use of water with BC government (i.e., need a licence to use water)
- Section 7: who may acquire licences (issued by Front Counter BC)
- Part 5, Sections 68 to 82: regulate wells and ground water protection, requiring well drillers be qualified, well reports be made, wells be identified, wells be properly deactivated, covered, and operated
- The Ground Water Protection Regulation, Part 1 outlines well drillers qualification requirements, and Part 2 outlines well construction requirements and gives a Code of Practice.

Wildlife Act: The provincial Wildlife Act protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

Fisheries Act: This Act has several sections of importance to water supply concerns:
- Sections 20, 21 and 22: may require installation and management of fish ways around obstructions
- Sections 27 and 29: prohibits obstructions to fish passage
- Section 30: requires water intakes to be screened to protect fish
- Section 35: prohibits harmful alteration, disruption or destruction of fish habitat unless authorized
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substance could include manure, soil, sediment)
- Section 37(4): requires approval for work that may impact fish habitat
- Section 38(4): requires reporting infractions of Sections 35 or 36

Migratory Birds Convention Act: This Act has a section of importance to water supply:
- Section 35(1): prohibits the deposit of any substance harmful to migratory birds in any waters frequented by migratory birds

Species at Risk Act: This Act has sections that protect listed species, their residence and critical habitat. It applies to federal lands, internal waters (i.e., all watercourses), territorial sea of Canada, and the air space above them.

The provisions of the Species at Risk Act (known as the ‘safety net’) could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.
Comply with applicable water supply related legislation, including the above, and where appropriate, use the following beneficial management practices to protect the environment.

**Water Quantity Protection**

**Farm Requirements.** Whether farm water originates from surface water, ground water or is supplied by purveyors, all water use should not exceed the following suggested rates:

- for livestock use, volume requirements given as peak daily use for livestock use, volume requirements given as peak daily use per animal
  - Livestock Watering Requirements - Quantity and Quality
- for irrigation purposes, water requirements given as peak flow rate and as annual volume use ➔ see Irrigation Water Use Checks, page 9-24

It is in the best interest of a farm to use only as much water as is necessary. Where possible, implement the following practices:

- conserve water use, allowing other users access to water
- conserve existing water to reduce the cost of developing new sources
  - reduced water use lowers requirements for water storage or water delivery
  - irrigation typically provides for the greatest opportunities for water conservation on most farms
  - Irrigation Tips to Conserve Water on the Farm

**Ground Water Use.** Withdrawal of ground water at rates faster than it can be replaced will lower the water table, and may impact levels and flows in adjacent watercourses. Indications of a lowering water table include:

- the necessity to deepen wells to maintain water flows
- wells running dry during times of the year when they previously had flow
- nearby bodies of surface water experiencing reduced flows or depths

To reduce the overuse of ground water, implement the following practices:

- monitor water tables regularly by measuring the static water level in wells at the same time of the year, each year (note some variations are normal)
- if the water table is lowering progressively over time (note that it may be due to changing climate or off-farm conditions or uses beyond control) reduce withdrawal to a sustainable level where the water table re-stabilizes

**Surface Water Use.** Producers using surface water must be aware of fish requirements. Excessive peak withdrawals may deplete water volume in a watercourse to the point of impacting fish and fish habitat. Also, removing volumes of water over the course of a season in amounts greater than allowable may deplete systems to such an extent that supply is insufficient for downstream users.

**Drought.** Hot, dry summers have become more frequent and more intense in certain regions of British Columbia. Drought can result in insufficient water supply or in severe cases, restrictions to water withdrawal for agricultural use. It is important to plan for sufficient water resources in times of drought by
implementing efficient irrigation and watering systems as well as being aware of how water restrictions can affect farming operations.


**Water Quality Protection**

**Backflow Prevention.** Backflow of contaminated water from any farm practice into a water source may occur through pipes that are cross connected. Implement the following practices:

♦ maintain a 30 cm (suggested) air gap between the water supply line and any tank containing a substance other than potable water to prevent backflow of non-potable water into the water supply

♦ install a backflow prevention device on water lines that can come into contact with contaminated water

→ see Chemicals Added to Irrigation Water, page 9-31

**Overland Water Flow.** Protect the water supply from overland flow of contaminated water.

→ see Runoff Flow Management, page 9-43

**Leachate.** Since surface water and ground water sources are often used for drinking water, potential contamination with substances such as pesticides and nitrates poses a serious health hazard. Ground water contamination is particularly difficult and very costly to clean up and needs to be avoided.

→ see Runoff Flow Management, page 9-43

→ see Leachate, page 9-48

**Springs.** Springs are ground water that becomes surface water flows upon exit from the ground. They are defined as watercourses under the *Water Act*. Protect springs from farm impacts by implementing the following practices:

♦ protect springs with a grassed buffer zone

♦ where a buffer zone is impractical, berms spring areas to prevent any contaminated runoff from entering

♦ direct spring flows away from contaminated farm areas

→ see Changes In and About a Stream, page 7-16

**Pumps.** Water pumps powered by petroleum-powered engines located near watercourses or water bodies create a risk of water contamination if fuel spills or leaks occur. To minimize the possibility of such contamination use secondary containment for any fuel tanks. Even small quantities of petroleum products can cause extensive water pollution.

**Changes In and About a Stream.** When planning any work in or near a watercourse, contact the appropriate agencies to ensure that it does not harmfully alter fish habitat or cause a deleterious substance to enter water.

→ see Changes In and About a Stream, page 7-16

**Water Quality Treatment**

In cases where water does not meet appropriate water quality standards, treatment for water quality may be an option. The following resources provide some guidance on appropriate water treatment options for several scenarios.

→ Treating Irrigation and Crop Wash Water for Pathogens

→ Chemigation Guidelines for British Columbia

→ Enhancing Livestock Water Quality

→ Treatment of Greenhouse Recirculation Water – Biosand Filtration
Wells and Ground Water Protection

Environmental concerns related to wells are associated with contaminants entering ground water either because of improper well construction or abandoned wells. Annually test that well water is potable and nitrate levels are acceptable. Possible additional concerns revolve around well water withdrawal rates that could decrease flow of affected watercourses.

Well Construction. Locate and construct wells to prevent seepage of both contaminated runoff and shallow ground water. Water in all wells should be sampled and the necessary field and laboratory tests made so that the ground water chemical and bacteriological quality of the well and its suitability for drinking water can be determined. The following parameters should be analyzed: total alkalinity, calcium, total hardness, total iron, magnesium, fluoride, nitrate, nitrite, pH, dissolved solids, specific conductance, turbidity and total coliforms.

Implement the following practices:
- construct new wells as required by the Ground Water Protection Regulation
  - sealing of the well casing surface to prevent entry of contamination
  - capping the well to prevent contamination entering
- locate new wells at least 30.5 m from storage and preparation areas for fertilizer, pesticides, petroleum products, manure, silage, etc (Public Health Act)
- locate wells in high areas, wherever possible, to prevent runoff from collecting around the well head and seeping into the water supply
- construct wells with durable materials
- construct well casings 0.3 m (suggested) above the level of surrounding land
- construct well casings above 100-year-flood levels (suggested)
- use a pitless adapter installed in the well casing where water lines may freeze (rather than terminating the casing in the ground below frost level)
- construct upland berms to prevent contamination of wells
- grade land areas near wells to direct surface water flows away
- plant and maintain grass covers around well heads to slow down and filter any nearby runoff

Guidelines for Minimum Standards in Water Well Construction
- Water Wells...that last for generations

Abandoned Wells. Seal wells no longer in use as required by the Ground Water Protection Regulation to protect aquifers. Ground water can be easily polluted if runoff flows into or around well casings. Seal materials should not compromise human health or drinking water quality, and should be more impervious than the native soils adjacent to the well. Seek professional advice if there is any doubt about sealant.

Wells Near Watercourses. Of particular concern are wells located near watercourses where water levels are sensitive to water withdrawal rates. Pumping from such wells should be discouraged or minimized during those times of the year when watercourse levels are critically low.
Licencing of Surface Water

The use of surface water requires a licence, issued by Front Counter BC. Water licences specify various conditions such as the purpose of use, the quantity of water, the amount of storage (if any), the time period during which it can be used, and the location of withdrawal and use.

- Understanding a Water Licence
- Water License Holders Rights and Obligations
- Water Rights in British Columbia

Water Withdrawal Rates. Until recently, water licences have not listed water withdrawal rates (e.g., a pumping rate in gallons per minute). If listed the rate is calculated based on proper irrigation methods. When withdrawing water, implement the following practices:

- if the licensed withdrawal rate is specified, check that the rate being used does not exceed this amount (Water Act)
- if the licensed withdrawal rate is not specified, check that the rate does not exceed the calculated peak flow rate for the region (suggested)
- for either of the above, see Irrigation Water Use Checks, page 9-24
- follow fish clauses listed on the licence, if present (Water Act)
- reduce water withdrawal if fish may be negatively impacted (Fisheries Act)

Annual Water Use. The licensed annual volume of water use must not be exceeded (Water Act), see Annual Water Use Check 2, page 9-24

Irrigated Area. Although a water licence is mainly concerned with water use, it does specify an acreage that may be irrigated and this should not normally be exceeded (Water Act). Some high efficiency irrigation equipment may be able to apply the licensed volume on a larger area.

Water Storage. A water licence may permit water storage, such as in a reservoir. In some regions, dugouts do not need to be licensed if the water stored is collected from on-farm runoff. If the dugout stores water coming from a watercourse, a water licence for storage and use is required. The maximum amount and when it is stored must match the water licence.

Domestic Water

Only use domestic water supplied from protected sources or treat appropriately. Surface water sources are particularly susceptible to contamination and therefore require constant monitoring. Under the Drinking Water Protection Act, if a system supplies more than one household or the general public the water provided must be potable. A regional health authority Drinking Water Officer may request that a source-to-tap assessment be done in these cases.

- Guidelines for Canadian Drinking Water Quality, available at:
- Cryptosporidium Infection
- Giardiasis ("Beaver Fever")
- How to Disinfect Drinking Water
- Water-borne Diseases in BC
Livestock Watering

To reduce possible livestock waste and traffic impacts on water quality, various systems are available that supply livestock water away from sensitive watercourse areas. A watering system is required where direct access to watercourses has been denied, such as in confined livestock areas. Systems may also be worthwhile for other outdoor areas experiencing less frequent animal activity. An outdoor watering system may include an intake, energy source, distribution system, and trough. Implement the following practices (refer to Figure 9.1, next page):

- use a watering system that reduces livestock impacts on watercourses
- meet intake regulations
  - see Changes In and About a Stream, page 7-16
- meet water intake fish screen requirements
  - see Water Intakes, page 9-16
- locate troughs 30 m or more (suggested) from a watercourse
- install troughs on a firm base such as concrete, wood, compacted soil or soil and gravel
- install water troughs to prevent the introduction of fecal contamination to the water that could contribute to disease and parasite problems
- use water conservation practices with troughs to minimize water usage
  - maintain a water freeboard of 25 to 50 mm (suggested) to avoid spillage
  - keep all water troughs maintained to eliminate leakage
- where required, ensure adequate drainage for spillage, overflow or leakage
  - contaminated overflow water must not pollute watercourses
- ensure that containment for fuel leaks from petroleum powered pumps
- re-vegetate ground disturbed for pipeline burial and system installation
- operate sites to prevent manure from contaminating watercourses
- in high-use situations, install an extended concrete apron or other suitable hard surface material around the waterer to minimize muddy conditions

Watering Livestock Directly from Watercourses

Livestock may impact a watercourse by activities in the uplands or the riparian area, or in the watercourse. Direct access to a watercourse by livestock may be either managed or unrestricted. Various factors will determine the preferred choice of access, including:

- livestock management, including timing, duration and intensity of use
- moisture content, and type of soil and vegetation within the riparian area
  - sites with bare soil or with sparse vegetation; sandy soils; saturated soils; clay soils; are more prone to erosion and may require improvements
- stream bottom composition
  - solid, gravelly areas, while providing good footing for livestock, are typically ideal for fish habitat (the habitat values of such sites must be known to determine the best type of access, if any)
- watercourses that experience high spring freshet flows may require managed access if their banks are highly eroded
- sensitive riparian areas with easily eroded stream banks
  - such areas may be limited to little or no access for long-term protection
- instream (such as fish) and downstream uses (e.g. domestic water intakes) of the water
Implement the following practices for livestock access to watercourses:

♦ do not reduce riparian function => see Riparian Areas, page 11-13
♦ contact the appropriate agencies when planning any work near or in any watercourse that may impact the water or habitat => see Changes In and About a Stream, page 7-16
♦ place salt, minerals or supplemental feeds away from riparian areas to encourage animal traffic in less sensitive locations
♦ use berms to prevent upland runoff flows from entering the watercourse at access locations, as shown in Figure 9.2, next page
♦ provide good footing and grades for livestock at access points
♦ clean up any accumulated manure from the sloped access from time to time
♦ for managed access, where possible, enclose the end of the access to prevent livestock from entering the watercourse as shown in Figure 9.2, next page (use removable panels on streams subject to high freshet flows)
♦ for managed access, fence or otherwise block unneeded access areas

**Unrestricted Access.** This option may have the greatest risk of pollution unless carefully matched to the livestock use. Evaluate such accesses with the characteristics of the site and degree of expected livestock activity in mind. This type of access is commonly used on sites of low density grazing, such as on dryland pastures. It may not be appropriate for high-use sites, such as summer-long grazing on irrigated pastures.
Managed Access. Restricting access will limit livestock impacts on water quality and sensitive streambank areas but will concentrate impacts onto the access site. Choose low-risk sites as access points. They may require some maintenance depending on the concentration of livestock. Use a fence or other means to control access and a small berm to redirect runoff away from directly flowing into the watercourse at the access location. Figure 9.2, below, illustrates a managed watercourse access.

![Managed Access to a Watercourse for Livestock](image)

In some cases improvements to the access may be needed because of soil, streambank, or intensity of use on the site. High-use, direct-access locations may benefit from improvements such as added gravel, a combination of added gravel and geosynthetics, or grading to modify slopes.

**Water Control Structures**

The construction of any structures such as dams, ditches, water diversions, bridges, and culverts located in watercourses are subject to fish-protection regulations. These govern such things as fish passage and timing, fish screening, and by-pass facilities. Prior to any work, ensure the fish requirements for the watercourse are known and regulations followed.
**Water Intakes**

**Intake Screen Sizing.** While intakes are usually screened to prevent debris from entering pipes, specific guidelines have been developed for fish bearing watercourses. The guidelines contain information on appropriate screen size for the intake flow rate. The following can be used to determine general compliance:

- ensure there is sufficient total screen area to match flow rate
  - use Worksheet #6, page 9-17
- use screen mesh sizes with clear openings that do not exceed 2.54 mm
- use screen mesh with open areas that are not less than 50% of the total screen area, Table 9.1, below

[**B.C. Sprinkler Irrigation Manual**](#)

**Intake Construction.** Installing an intake may require working along side or in a watercourse. Any work requiring “changes in and about a stream” requires an approval, licence or compliance with regulations.

⇒ see Changes In and About a Stream, page 7-16

**Intake Maintenance.** The maintenance of intake works authorized by a water licence must be conducted in a manner and during a period that minimizes water quality impacts on existing licensed users and fish. If in doubt, contact MOE or DFO ⇒ see Changes In and About a Stream, page 7-16

---

### Table 9.1 Screen Mesh Open Area

<table>
<thead>
<tr>
<th>Mesh</th>
<th>Wire Diameter</th>
<th>Width of Opening</th>
<th>Open Area %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[inch]</td>
<td>[mm]</td>
<td>[inch]</td>
</tr>
<tr>
<td>4 x 4</td>
<td>0.063</td>
<td>1.60</td>
<td>0.188</td>
</tr>
<tr>
<td>6 x 6</td>
<td>0.035</td>
<td>0.889</td>
<td>0.132</td>
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<tr>
<td>8 x 8</td>
<td>0.028</td>
<td>0.711</td>
<td>0.096</td>
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<td>10 x 10</td>
<td>0.025</td>
<td>0.635</td>
<td>0.074</td>
</tr>
<tr>
<td>12 x 12</td>
<td>0.023</td>
<td>0.584</td>
<td>0.060</td>
</tr>
</tbody>
</table>

Source: B.C. Sprinkler Irrigation Manual

★ Screen mesh size openings exceed the maximum fishery opening size of 2.54 mm (0.1 inch)
**Worksheet #6**

**Screen Area Check**

**for Fishery Requirements of Water Intakes**

**Workbook Question 264**

**Question:** An irrigation system with an intake in a fish-bearing stream has a flow rate of 963 US gpm. The intake screen is a four-sided box, each side being 5 ft long and 2 ft wide using 8 x 8 mesh. The ends are solid and not screened. Does the screen surface area match fishery requirements for the flow rate?

**Information:**

| Irrigation system flow rate, from Box 9 on Worksheet #7 or #8 | US gpm |
| Screen mesh size used | mesh size |
| Percent screen open area of mesh size used, Table 9.1 | % open area |

Check if end area is screened: NO

**Calculation:**

Step 1 Calculate required screen surface area

**Equation:**

\[
\text{Required Screen Surface Area} = 0.448 \times \% \text{ Open Area}
\]

- \(\text{Flow Rate}\) = 963 gpm, \(\% \text{ Open Area}\) = 60

\[
= 0.448 \times 60 = 35.8 \text{ sq. feet}
\]

Step 2 Calculate actual screen area using one of the following methods: (Add end area if screened)

**Method 1:** Flat screen

**Equation:**

\[
\text{Flat Surface Area Total} = \text{No. of flat Screen Surfaces} \times \text{Length} \times \text{Width}
\]

- \(\text{No. of flat Screen Surfaces} = 4\), \(\text{Length} = 5\) ft, \(\text{Width} = 6\) ft

\[
= 4 \times 5 \times 6 = 40.0 \text{ ft}^2
\]

**Equation:**

\[
\text{End Surface Area} = \text{Length} \times \text{Width}
\]

- \(\text{Length} = 9\) ft, \(\text{Width} = 10\) ft

\[
= 9 \times 10 = 90 \text{ ft}^2
\]

**Total Area** = 40.0 ft² + 90 ft² = 130 ft²

**Method 2:** Cylindrical screen

**Equation:**

\[
\text{Cylindrical Surface Area} = 3.14 \times \text{diameter} \times \text{length}
\]

- \(\text{diameter} = 13\) ft, \(\text{length} = 14\) ft

\[
= 3.14 \times 13 \times 14 = 60.0 \text{ ft}^2
\]

**Equation:**

\[
\text{Circular End Area} = 3.14 \times \text{diameter}^2
\]

- \(\text{diameter} = 13\) ft

\[
= 3.14 \times 13^2 = 400.0 \text{ ft}^2
\]

**Total Area** = 60.0 ft² + 400.0 ft² = 460.0 ft²

**Answer:**

Is 35.8 sq. feet less than 40.0 or 12 or 17 sq. feet? YES screen area is OK
IRRIGATION


IRRIGATION ENVIRONMENTAL CONCERNS

Primary environmental concerns related to irrigation are:
- irrigating with poor quality water that results in contamination of edible crops with pathogens, or in salt build up in the soil
- over irrigation that results in
  - poor conservation of water
  - leaching of contaminants into ground water or surface water
  - overland flow leading to soil erosion
- chemigation materials or other additives that results in water or soil pollution

For information on these concerns:
→ see Soil Quality Factors, page 8-2, and refer to Contaminants, and to Salts
→ see Water Quality and Quantity factors, page 9-2, and refer to Contaminants

IRRIGATION LEGISLATION

The following is a brief outline of the main legislation that applies to irrigation.
→ see page A-1 for a summary of these and other Acts and Regulations

Local Bylaws
Municipalities, irrigation districts and other water purveyors may have bylaws governing the application of chemicals through irrigation system.

BC Building Code
Part 7 of the BC Building Code addresses plumbing services and provides information on protection from contamination from cross connections.

Wildlife Act
The provincial Wildlife Act protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

Fisheries Act
This Act has two sections of importance to irrigation (chemigation):
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substance could include chemigation water)
- Section 38(4): requires reporting infractions of Section 36
Species at Risk Act

This Act has sections that protect listed species, their residence and critical habitat. It applies to federal lands, internal waters (i.e., all watercourses), territorial sea of Canada, and the air space above them.

The provisions of the Species at Risk Act (known as the ‘safety net’) could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

IRRIGATION BENEFICIAL MANAGEMENT PRACTICES

Comply with applicable irrigation related legislation, including the above, and where appropriate, use the following beneficial management practices to protect the environment.

A key objective of irrigation management is the efficient use of water to match the crop’s needs while preventing the loss of water due to surface flow, leaching or drift. Appropriate irrigation designs, equipment and good management and scheduling will conserve water supplies while supporting crop growth.

The Role of Soil in Irrigation

Good irrigation practices combine proper irrigation system design, system operation and maintenance and irrigation scheduling. Soil characteristics determine how an irrigation system should be designed and operated:

♦ coarse textured sandy soils generally have low water holding capacity and high infiltration rates
  • water is therefore unlikely to pond on or run off the surface
  • however, water may be lost beyond the root zone quickly and may carry with it nutrients, posing a hazard to ground water quality
  • irrigate when required and only long enough to fill the root zone

♦ medium to fine-textured silt and clay soils are very susceptible to surface sealing or puddling of soil, which can lead to very low infiltration rates
  • water droplets from sprinkler systems may damage soil structure on bare soils - protect surface from sealing with crop cover or mulch
  • reduce droplet size and operation time on bare soil (e.g., new seedings)
  • allow soil to dry out between irrigations letting surface cracks to appear which may improve infiltration

♦ a sealed soil surface discourages infiltration and promotes ponding and runoff flow causing erosion
  • operate sprinkler systems in the spring and fall with a longer time between each irrigation than during periods with peak water use
  • manage trickle systems to keep the soil water level within the optimum range, but definitely not saturated

♦ poorly drained soils may experience a salt build up when irrigated (from salt already in the soil or in the water) – when the soil dries, ‘salty’ water is drawn up to the soil surface, the water evaporates and the salt stays
  • over irrigate and drain to remove salt build up

Soil Water Storage Capacity and Available Soil Moisture
Irrigation Water Quality

Irrigating with water of poor quality can not only harm or contaminate the crop, but may also harm the environment. Salts, heavy metals and pathogens make their way into the soil and may be taken up by the crop or build up in the soil to unacceptable levels.

- see Salts, page 8-5
- see Soil Contamination – Salt Check, page 8-17

Table 9.2, below, provides threshold values for irrigation water quality tests. If these values are exceeded the water quality should be further investigated, treated or not used. For high pathogens levels, producers are encouraged to eliminate potential sources of contamination by implementing beneficial management practices. If on-farm changes in practice do not result in improved water quality then the producer should seek an alternate source or treat the water. For pathogens, test a water sample for E. Coli and fecal coliforms, measured in colony forming units (cfu).

More water quality information can be found in:
- B.C. Sprinkler Irrigation Manual, chapter 10
- B.C. Trickle Irrigation Manual, chapter 12
- Treating Irrigation and Crop Wash Water for Pathogens

<table>
<thead>
<tr>
<th>Table 9.2 Irrigation Water Quality Guidelines 1</th>
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<tr>
<td><strong>Threshold Values to Protect Soil 2</strong></td>
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<tr>
<td><strong>Salts</strong></td>
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<td><strong>Chloride</strong></td>
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<td><strong>Threshold Values for Food Safety 3</strong></td>
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<tr>
<td><strong>E.Coli</strong></td>
</tr>
<tr>
<td><strong>cfu / 100ml</strong></td>
</tr>
<tr>
<td><strong>Pathogens 4</strong></td>
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</tr>
</tbody>
</table>

1 If these values are exceeded the water quality should be further investigated, treated or not used
3 from BC MOE
4 Note: Pathogen levels for crop washing are 0 cfu / 100ml for both E.coli and fecal coliform

Irrigation Systems

The type of irrigation system most suited to a particular site depends on crop characteristics, climate and soil conditions. When deciding on an irrigation system, implement the following practices:

- consider water and soil conservation issues as well as economics
- when appropriate, select an irrigation system with efficient water use such as trickle or subsurface system
- see Application Efficiency, page 9-22
- apply water using scheduling techniques
- see Irrigation Water Scheduling, page 9-23
where appropriate, install electronic timing devices to automate the system and adjust the device regularly to irrigate according to changing climate conditions over the irrigation season.

**Trickle.** Trickle systems can be the most efficient at using water if managed properly but they are not suited for all cropping systems, soil conditions or water quality. In this guide, trickle refers to frequent, low pressure application of water to crops, including tape, drip emitters and spray emitter systems.

**Sprinklers.** Some sprinkler systems can be very efficient and make good use of water while others with poor uniformity or poor management will have water and nutrient loses due to deep percolation and overland flow.

**Guns.** These systems operate at much higher flows and pressures than regular sprinkler systems. They are susceptible to wind drift, resulting in higher evaporation losses and lower operating efficiencies. Stationary guns have a very high application rate requiring short set times that may be difficult to properly manage. Traveling guns also have lower efficiencies, but overcome the short set time by moving the gun over a large area each set.

**Centre Pivots.** These systems are automated and travel in a circle around a field. Those with higher efficiencies use low volume spray heads.

**Flood.** Flood irrigation is an inexpensive irrigation option. However it is an inefficient method of irrigating, especially when fields are not laser leveled. Flood systems can have water losses due to tail end losses (which are not recycled) and deep percolation if too much water is applied. The excess water can contain nutrients or contaminants that may impact surface or ground water.

**Subirrigation.** These systems use subsurface drainpipes to irrigate by raising the water table to the crop’s roots. Drainpipes require a closer spacing than a system that only provides drainage. Managed properly, these systems can provide an efficient use of water and, if the drainage system is controlled and closed, recycle nutrients that may have leached in to the drain water. These systems are not appropriate for crop cooling or chemigation.

**Controlled Drainage/Subirrigation**

The design of the irrigation system should match the application rate of the irrigation system to the soil type and the crops’ water requirements. Proper design and operation should prevent water from being wasted, and minimize surface flow or leachate that may contain fertilizer and pesticide residues. An irrigation system that is not properly designed will be nearly impossible to manage properly. Manage excess water to avoid the following consequences:

- **erosion** – adjust system or rate of application to reduce overland flow
- **transport of nutrients** via leaching out of the root zone and into the ground water – this is expensive and can cause pollution
- **transport of nutrients** into runoff flow
- **insufficient water** may allow salts to built up in the soil
- **match the irrigation flow rate and water use with the recommended values**
  - producers should be able to reduce their water use if rates exceed recommended values
    - see Irrigation Water Use Checks, page 9-24
- **have secondary containment for fuel tanks on petroleum powered pumps near watercourses**
Application Efficiency. Application efficiency is the percentage of water applied by the irrigation system that is actually available to the crop. A lower efficiency system loses more water during the application process to evaporation, wind drift, or runoff and is not available to the crop. Efficiencies can vary due to:

- the type of irrigation system
- operating conditions, such as wind, system pressure, sprinkler trajectory, etc
- time of day
- hot or cool weather

Table 9.3, next page, gives efficiencies of commonly used systems. When considering irrigation system efficiency, implement the following practice:

- for new systems, choose the most efficient system suitable for the crop
- for upgrading existing systems, choose a system that is at least 15% greater efficiency than the present one (e.g., for tree fruits, going from an undertree solid set sprinkler system, at 75%, to a trickle system, at 92%)

Irrigation System Operation

When operating irrigation systems implement the following practices:

- operate a sprinkler irrigation system at the recommended operating pressure
  - excessive pressure can be inefficient and result in water loss due to evaporation and wind drift
- avoid excess irrigation that causes runoff flow, such as in compacted low areas that are prone to ponding and/or runoff flow
  - runoff flow can cause soil erosion
- avoid excess irrigation that causes leachate movement
- irrigate the crop only
  - avoid applying water to non-productive areas, such as roads
- when possible, irrigate during late night or early morning hours when evaporation and wind losses are generally lower
  - this is usually not possible during peak summer heat conditions as withdrawal rate limits (water licence) require 24 hour irrigation
- use automated systems to apply the amount of water required for the crop during that time period to reduce over and under watering
- avoid irrigating with high volume sprinklers on steep hills (over 10 percent gradient)
<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Irrigation System Type</th>
<th>Application Efficiency (%)</th>
<th>Worksheets #9, #10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Row</td>
<td>Trickle</td>
<td>80 – 90, 85</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Microjet</td>
<td>85 – 95, 92</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trickle</td>
<td>85 – 95, 95</td>
<td></td>
</tr>
<tr>
<td>Row</td>
<td>Sprinklers</td>
<td>60 – 75, 72</td>
<td></td>
</tr>
<tr>
<td>Field</td>
<td>Handmove</td>
<td>60 – 75, 72</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wheel line</td>
<td>60 – 75, 72</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overhead Solid Set</td>
<td>60 – 75, 72</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Undertree Solid Set</td>
<td>65 – 75, 75</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Microsprinklers</td>
<td>70 – 85, 80</td>
<td></td>
</tr>
<tr>
<td>Field</td>
<td>Center Pivot</td>
<td>65 – 75, 72</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sprinklers</td>
<td>65 – 75, 72</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spray heads</td>
<td>65 – 75, 72</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drop tubes</td>
<td>75 – 85, 80</td>
<td></td>
</tr>
<tr>
<td>Row</td>
<td>Guns</td>
<td>50 – 65, 58</td>
<td></td>
</tr>
<tr>
<td>Field</td>
<td>Stationary</td>
<td>50 – 65, 58</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Travelling</td>
<td>55 – 70, 65</td>
<td></td>
</tr>
<tr>
<td>Field</td>
<td>Flood</td>
<td>30 – 50, 50</td>
<td></td>
</tr>
</tbody>
</table>

* these are typical crops irrigated with these systems: Row = crops such as tree fruits, grapes  
  Field = crops such as forages, field vegetables

Irrigation Water Scheduling

Irrigation scheduling is the process used to match the application of irrigation water to the soil and crop needs. The key objective of irrigation scheduling is to reduce water loss due to overland flow or leaching.

There are a number of ways that the system can be operated to match climate conditions. Some farms alter the operating time throughout the season to match climate conditions and crop growth requirements. Others keep the operating time the same but change the frequency of operation. Either method can be used to match system operation with climate conditions.

Irrigation scheduling requires knowing:
- the soil water holding capacity of the soil
- the amount of evapotranspiration (ET) and precipitation (climate information)
- the application rate of the irrigation system

For appropriate irrigation scheduling implement the following practices:
- irrigate according to crop requirements instead of a rigid time-table
- monitor soil moisture (below)
- monitor climate information and be aware of the forecast (refer below)
- consider recent rainfall events, and evapotranspiration
  - i.e., the amount of water to be added to the soil depends on how much has been removed by the crop and added by rainfall since the last irrigation
  - irrigation begins when a significant amount of water has been removed from the soil in the root zone, 50% for sprinkler systems and 20 to 30% for trickle systems
- use a water budget method to determine when and how long to irrigate
The online Irrigation Scheduling Calculator has been developed specifically for use in British Columbia. The calculator takes the following information into account in the development of an irrigation schedule:

- crop water requirements
- soil water holding capacity
- amount of effective rainfall that is useable by the crop
- how much irrigation water is needed to make up the moisture deficit

http://www.irrigationbc.com/

Agriculture Drip Irrigation Scheduling Calculator Users Guide
Agriculture Sprinkler Irrigation Scheduling Calculator Users Guide
Sprinkler Irrigation Scheduling Using a Water Budget Method
Trickle Irrigation Scheduling Using Evapotranspiration Data

Soil Moisture. The need for irrigation should never be gauged by the moisture content of the soil surface layer alone. It is important to determine the moisture content throughout the root zone to make an educated decision on when to start irrigating by using the hand feel method or monitoring devices such as tensiometers, gypsum blocks or electrical resistance blocks.

Irrigation Scheduling Techniques
Irrigation Scheduling with Tensiometers

Climate Monitoring. The crop’s water use is directly related to the climate. Climate information can be gathered on the farm or taken from regional sources such as Farmwest.com on the Internet.

www.Farmwest.com and go to “Evapotranspiration” under the Climate tab

Irrigation System Maintenance

To ensure an irrigation system performs as designed it must be maintained properly. Implement the following practices:

- check irrigation equipment for leaks
  - common faults include leaking gaskets, defective sprinkler bearings and uneven pressure due to incorrect pipe sizes or difference in elevation
- check nozzles annually for wear
  - worn, oversized nozzles will apply excess water to the crop
  - in areas where the water contains sediment check more frequently
- check trickle system emitters annually for signs of clogging
  - plugged emitters cause uneven water distribution
- have a maintenance routine for water pumps, checking for impeller wear

Irrigation System Maintenance

Irrigation Water Use Checks

Two water use checks can be done on existing systems to determine if the irrigation water use is appropriate. Implement the following practices:

- do a Peak Flow Rate Check for water withdrawal rate
  - explanatory text on pages 9-25 to 9-26
  - see Worksheet #7 for sprinkler systems, page 9-27
  - see Worksheet #8 for trickle systems, page 9-28
- do an Annual Water Use Check for total water use
  - explanatory text on pages 9-29 to 9-31
  - see Worksheet #9 for sprinkler systems, page 9-32
  - see Worksheet #10 for trickle systems, page 9-34
These Worksheets are available in the Environmental Farm Planning Workbook for individuals to use with actual farm numbers. If either check fails, a more detailed system assessment should be done; go to Irrigation System Assessment Guide below.

Irrigation System Assessment Guide is a publication that forms part of the Environmental Farm Plan series on Beneficial Management Practices. Its purpose is to provide a more detailed assessment that provided by the following Water Use Checks.

These Water Use Checks will indicate which producers should refer to this publication for further assistance. The publication will also be of interest to producers who want to improve irrigation management or have experienced water shortages. Table 9.4, below, will direct producers who have systems that need a more detailed review.

### Table 9.4  Steps to Complete an Irrigation System Assessment

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1.   | Do The Two Water Use Checks (using either the Sprinkler or Trickle worksheets)  
   - check the irrigation system Peak Flow Rate – match farm rate to the licensed rate or the calculated rate  
   - check the irrigation system Annual Water Use- match farm use to the licensed rate and the calculated rate  
   If both checks are answered “Yes”, the irrigation system water use is appropriate and no further action is necessary. |
| 2.   | If Either of the Water Use Checks are Answered “No”, Assess the System  
   - do a detailed assessment using the Irrigation System Assessment Guide publication  
   - this publication builds on the Water Use Checks with more detailed information  
   - it includes additional Worksheets as well as Actions that can be taken to adjust the system to use water appropriately  
   - this level of assessment is useful for systems that require only minor adjustments  
   If the irrigation system still does not meet water use requirements, professional assistance is needed. |
| 3.   | Where Required, Have an Irrigation Management Plan Done by a Professional  
   - at this level the irrigation system requires significant analysis  
   - this should be done by a professional certified by Irrigation Industry Association of BC |

### Irrigation System Peak Flow Rate Check

The irrigation system should be designed and operated so that the peak flow rate of the system matches the climate, crop and soil requirement. This check compares a calculated peak flow rate to the actual irrigation system flow rate. Complete the following three steps as given in Worksheet #7 (Sprinkler), page 9-27 or Worksheet #8 (Trickle), page 9-28.

**Step 1: Calculated Peak Flow Rate.** The calculated peak flow rate is the rate of water withdrawal determined by using the estimated rate for the farm location in BC. These are established rates, given in Appendix Table B.2, page B-5. The rate is multiplied by the acreage being irrigated to give a Calculated Peak Flow Rate.

**Step 2: Actual System Peak Flow Rate.** The actual system flow rate can be determined using any one or more of the following methods:

- **Water Meter.** A system water meter can be used to determine the peak flow rate. If the meter does not directly provide the rate, measure the time the meter indicates a certain amount of water has passed and divide this volume by the time to determine the flow rate.
♦ **Water Purveyor.** Water purveyors will allocate a flow rate to the farm based on acreage. Most often these flow rates are regulated using flow control valves. Contact your water purveyor to find out how much water you are allowed to take if you are on a municipal system or in an irrigation district.

♦ **Pump Curve.** The system flow rate can be determined by estimating the flows using the pump curve. When using a pump curve to estimate flow, the impellor diameter, pump rpm, and system operating pressure must be known. Contact your pump supplier for pump curve information.

♦ **Sprinkler Nozzle.** The irrigation system flow rate can be determined by measuring the flow rate (using a pail and stop watch) from selected sprinklers, averaging the flow and multiplying this number by the number of sprinklers operating. Alternatively, nozzle manufacturer table values can be used once the operating pressure and nozzle sizes are known.

It is important that all sprinkler nozzles are the same size and operating at close to the same pressure (i.e., they have similar flow rates) or the check will be inaccurate. Loss or gain of pressure is evident if the sprinklers at the end of the lateral do not have the same flow rate as those at the start. The lateral lines should be operated on the contour whenever possible. If the laterals run up or down a steep slope each sprinkler will be operating at a different pressure. For sprinkler system output flow using nozzle flow, use Worksheet #7.

♦ **Trickle Systems.** These systems are much more efficient than sprinkler systems and can therefore operate at lower flow rates, if desired. However, to conduct a peak flow rate check, the same estimated peak flow rate is used for the sprinkler check. The reasons for this are:
  - the farm may convert to an alternate crop requiring a sprinkler irrigation system; the farm flow rate should be able to accommodate the change
  - water licences do not incorporate system types into the determination of flow rates; the allowable withdrawal is based on the sprinkler flow rate
  - irrigation districts provide flows based on sprinkler flow requirements
  - an advantage of trickle systems is that the system does not need to operate 24 hours per day if the sprinkler systems peak flow rate is used

For trickle output flow using drip emitter flow, use Worksheet #8.

**Step 3: Compare the Flow Rates.** To complete the peak flow rate check, compare the calculated peak flow rate or the licenced rate to the actual irrigation system flow rate. If a rate is given on the water licence, the actual use must not exceed it. If no rate is indicated, it is recommended that the actual flow rate be no greater than the calculated flow rate.
**Worksheet #7 System Peak Flow Rate Check - Sprinkler Workbook Question 271**

**Question:** A farm in Armstrong irrigates 170 acres. The irrigation pump curve indicates a flow rate of 825 US gpm. The irrigation system has 105 sprinklers with 3/16” x 3/32” nozzles operating at 40 psi.

Does the system flow rate match either the licensed withdrawal rate (if stated) or the calculated peak flow rate for the farm?

**Information:**

- Irrigated area: 170 acres
- Either peak flow rate on water license (if stated): n/a
- OR, select location to look up peak flow:
  - Armstrong: 5 US gpm/acre

**Calculation:**

**Step 1:** Determine calculated peak flow rate

**Equation:**

\[
\text{Calculated Peak Flow Rate} = \text{Estimated Peak Flow Rate Requirement per Acre} \times \text{Irrigated Area} \]

\[
= \frac{5}{3} \text{ US gpm/acre} \times 170 \text{ acres} = 850 \text{ US gpm} \]

**Step 2:** Determine actual irrigation system flow rate using one or more of the following methods:

- **Method 1.** Water purveyor restriction or measured flow rate using a meter
  - Flow rate measured using a meter or provided by district: 5 US gpm

- **Method 2.** Pump peak flow rate
  - Irrigation pump peak flow from pump curve: 825 US gpm

- **Method 3.** Determine flow rate using sprinkler nozzles
  - Nozzle flow rate from supplier’s tables
    - Nozzle flow rate: 8 US gpm
    - Number of nozzles: 105

**Equation**

\[
\text{Sprinkler System Output Flow Rate} = \text{Nozzle Flow Rate} \times \text{Number of Nozzles} \]

\[
= \frac{8}{7} \text{ US gpm} \times 105 \text{ nozzles} = 840 \text{ US gpm} \]

**Answer:**

**Step 3:** Check sprinkler irrigation system peak flow rate (methods 1, 2 or 3) with calculated peak flow rate or Water Licence peak flow rate.

Is \(850\) 2 or 4 greater than \(840\) Maximum of 5, 6 or 9 US gpm

Flow rate is not exceeded
**Worksheet #8 System Peak Flow Rate Check - Trickle Workbook Question 271**

**Question:** An orchard in Kelowna has a trickle irrigation system irrigating 14 acres. The largest zone with the most emitters and highest flow rate is zone 4. It has 756 trickle emitters with an emitter flow rate of 5.7 gph. Does the system flow rate meet either the licensed water withdrawal rate (if stated) or the calculated peak flow rate?

**Information:**

<table>
<thead>
<tr>
<th>Irrigated area</th>
<th>14</th>
<th>1</th>
<th>acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR, select location to look up peak flow: Kelowna</td>
<td>6</td>
<td>3</td>
<td>US gpm/acre</td>
</tr>
</tbody>
</table>

**Calculation:**

**Step 1:** Determine calculated peak flow rate

**Equation**

\[
\text{Calculated Peak Flow Rate} = \text{Estimated Peak Flow Rate per Acre} \times \text{Irrigated Area}
\]

\[
= 6 \text{ US gpm/acre} \times 14 \text{ acres} = 84 \text{ US gpm}
\]

**Step 2:** Determine actual irrigation system flow rate using one or more of the following methods:

- **Method 1.** Water purveyor restriction or measured flow rate using a meter
  
  Flow rate measured using a meter or provided by district = 5 US gpm

- **Method 2.** Pump peak flow rate
  
  Irrigation pump peak flow from pump curve = 6 US gpm

- **Method 3.** Determine flow rate using trickle emitters
  
  **Equation**
  
  \[
  \text{Trickle System Output Flow Rate} = \text{Emitter Flow Rate} \times \text{No. of Emitters} \times 0.0167
  \]
  
  \[
  = 5.7 \text{ gph} \times 756 \text{ emitters} \times 0.0167 = 72.0 \text{ US gpm}
  \]

**Answer:**

**Step 3:** Check sprinkler irrigation system peak flow rate (methods 1, 2 or 3) with calculated peak flow rate or Water Licence peak flow rate.

Is 84 2 or 4 greater than 72.0 Maximum of 5, 6 or 9 US gpm

**Flow rate is not exceeded**

---

This check compares the annual water use of an existing irrigation system against the licenced amount (surface water use) and against the calculated annual water requirement for the farm location (licenced surface water use, ground water use or purveyor-supplied water). If the check indicates that the annual water use exceeds the licenced rate or the calculated requirement the system design and / or the operation of the system needs to be reviewed.
Complete the following three steps as given in Worksheet #9 (Sprinkler), page 9-32 or Worksheet #10 (Trickle), page 9-34.

If licensed, water volume is checked against both the licence and the calculated water requirement. This double check ensures that the licence is not exceeded and water use meets the expected amount for the location.

It is possible that the water licence allows for more water than the calculated annual water requirement would indicate for either of two reasons:
- water licences are not always issued for the exact amount of water required but may be “rounded off” to the next one-half acre-foot of water
- an old water licence may have been issued for flood irrigation with up to twice as much water as a newer water licence for sprinkler irrigation

Therefore, when checking actual annual water use against older licensed volumes, there may still be opportunities for water savings, even if using less than the amount stated on the licence.

**Understanding a Water Licence**

**Irrigation System Assessment Guide**

For systems that have large conveyance losses between the diversion and the irrigation system intake, the conveyance losses must be determined before the annual water use check can properly be completed.

**Step 1: Calculated Annual Water Requirement.** The calculated annual water requirement is determined using an estimated value for crop water requirements and irrigation system efficiency factors.

It is accepted that some years are wetter or drier than others and annual water use will vary. Regardless, the annual withdrawal amounts stated on a water licence cannot be exceeded. Farmers using a well or other water source should adhere to the annual water requirement figures calculated in this chapter whenever possible.

- **Sprinkler Systems.** To calculate the sprinkler annual water requirement use, use Worksheet #9. This calculation requires the system efficiency to be considered. Typical system efficiencies are given in Table 9.3, page 9-23.

- **Trickle Systems.** The trickle system irrigates less of the crop area than a sprinkler system. The trickle emitters apply water only to the plant roots and not the centre of the crop row. The efficiency of a trickle irrigation system is also much higher than sprinkler systems, which provides additional savings. Table 9.5, next page, provides factors that can be used to adjust the annual crop water requirement values in Appendix Table B.3, page B-7 for trickle irrigation systems. Use Worksheet #10.
Table 9.5 | Crop Adjustment Factors for Trickle Irrigation Systems

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Adjustment Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree Fruits – High Density</td>
<td>1.00</td>
</tr>
<tr>
<td>Apples - Cherries – Medium Density</td>
<td>0.90</td>
</tr>
<tr>
<td>Apricots, Peaches, Pears – Medium Density</td>
<td>0.80</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>0.90</td>
</tr>
<tr>
<td>Vegetables</td>
<td>0.80</td>
</tr>
<tr>
<td>Blueberries</td>
<td>0.80</td>
</tr>
<tr>
<td>Strawberries</td>
<td>0.75</td>
</tr>
<tr>
<td>Raspberries</td>
<td>0.70</td>
</tr>
<tr>
<td>Grapes</td>
<td>0.70</td>
</tr>
</tbody>
</table>

**Worksheet #10**

**Step 2: Actual System Annual Water Use.** The annual water use by an irrigation system can be determined using meter data, pumping information or irrigation system operation information. Any of the following methods can be used to estimate the annual water use. More than one method may be used to determine as accurately as possible the amount of water used each year.

- **Water Meter.** A water meter will provide accurate information on annual water use. Metered systems are usually on municipal or irrigation district water supplies; however, there are very few irrigation systems that are currently metered. Trickle irrigation systems often have a flow meter to monitor system performance, but these meters do not provide annual data. The meter reading can be converted into annual water use.

- **Pump Operating Hours.** The pump operating hours of an electric irrigation pump may be determined from the hydro bill provided by the hydro supplier. The amount of energy used can be converted into operating hours and annual water use.

  To determine the pump horsepower use the pump curve to determine the actual horse power. You will need to know the flow rate, which is calculated in Worksheets #7 or #8, and the pressure at the pump. Relying on the motor face plate information may mean that the horse power used in the calculation is too large.

- **Sprinkler Systems.** Annual water use for a sprinkler system can be estimated by determining how many days it takes the irrigation system to cover the field, the number of irrigations that are applied each year and the peak flow rate of the irrigation system. Use Worksheet #9.

- **Trickle Systems.** Trickle irrigation systems are more efficient than most other irrigation systems. They are also operated more frequently than other systems, usually every day or numerous times every week. Use Worksheet #10, to convert system information into annual water use.
Step 3: **Compare the Water Use Rates.** To complete the Annual Water Use Check, compare the calculated annual water requirement to the annual water use. It is recommended that the annual water use be no more than 110% of the calculated annual water requirement (i.e., the requirement is not exceeded by more than 10%).

**Step 4: Water Licence Check.** Convert the actual annual water use calculated in inches to acre-feet (Worksheets #9 and #10). The acre-foot value is required if the actual annual water use is to be checked against the irrigation licence. The annual water use in acre-feet should not exceed the amount stated on the water licence.

**Chemicals Added to Irrigation Water**

Chemigation is the practice of injecting chemicals into an irrigation system for application to a crop or field. Chemicals that are injected include fertilizers, herbicides, insecticides, fungicides, nematocides and growth regulators. Chemigation may reduce the amount fertilizers required as nutrients are applied more efficiently.

Uniformity is essential to prevent over application of fertilizer or pesticide. The risk of contamination of the water source due to back-siphonage and back-pressure (as in unexpected shutdown of the irrigation system during injection) is an additional concern. Implement the following practice:

- have an irrigation system designed to ensure uniformity
  - sprinkler systems should have a minimum uniformity of 80%
  - trickle systems should have a minimum uniformity of 90%
  - have new systems designed by a certified irrigation designer
- calibrate equipment and follow proper chemigation procedures to minimize the risk of excessive application and chemical drift
- have a proper backflow prevention device
- follow the information and regulations in the Chemigation Guidelines

Producers who add chemicals to irrigation water should refer to the following publications for system detail required to be able to apply chemicals without impacting the environment.

- [BC Trickle Irrigation Manual](#), chapter 14
- [Chemigation Guidelines for British Columbia](#)
- [Irrigation System Cross Connection Control](#)
- [B.C. Irrigation Management Guide](#)
Question: A farmer in Armstrong irrigates 170 acres. The 125 hp irrigation pump operates at a flow rate of 825 US gpm. The electric bill indicates there was 140,337 KWh of hydro use. The wheelmove sprinkler irrigation system has an efficiency of 72% and takes 15 days to cover the field. The field was irrigated 4 times during the year. The water licence amount is 262 acre-feet. Does the annual water use match the calculated annual irrigation water requirement for the farm?

Information:

<table>
<thead>
<tr>
<th>Water withdrawal amount on water license (if applicable)</th>
<th>262</th>
<th>2 acre-feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated annual crop water requirement (select site)</td>
<td>Armstrong</td>
<td>12</td>
</tr>
<tr>
<td>Application efficiency (select irrigation type)</td>
<td>Microjet</td>
<td>85</td>
</tr>
</tbody>
</table>

Calculation:

Step 1. Determine the calculated annual water requirement.

**Equation:**
\[
\text{Calculated Annual Water Requirement} = \frac{\text{Estimated Annual Crop Water Requirement}}{\text{Application Efficiency}} \times 100\%
\]

<table>
<thead>
<tr>
<th>Estimated Annual Crop Water Requirement</th>
<th>170</th>
<th>1 acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Efficiency</td>
<td>85</td>
<td>4 %</td>
</tr>
</tbody>
</table>

Step 2. Determine actual annual water use using one or more of the following methods:

**Method 1: Metered water use**

**Equation:**
\[
\text{Annual Water Use} = \frac{\text{Meter Reading at End of Year} - \text{Meter Reading at Start of Year}}{27027 \times \text{Irrigated Area}}
\]

<table>
<thead>
<tr>
<th>Meter Reading at Start of Year</th>
<th>6</th>
<th>US gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter Reading at End of Year</td>
<td>5</td>
<td>US gallons</td>
</tr>
<tr>
<td>Irrigated Area</td>
<td>170</td>
<td>1 acres</td>
</tr>
</tbody>
</table>

**Method 2: Pump water use**

**Equation:**
\[
\text{Pump Power} = \text{Pump Horsepower} \times 0.746 \text{ KW/hp}
\]

| Pump Horsepower from supplier's table | 125 | 9 hp |

**Equation:**
\[
\text{KWh for Entire Year} = \frac{\text{Energy consumption for entire year from hydro bill}}{\text{Pump flow rate from pump curve}}
\]

| Energy consumption for entire year from hydro bill | 140,337 | 10 KWh |
| Pump flow rate from pump curve                    | 825      | 11 US gpm |

**Equation:**
\[
\text{Annual Water Use} = \frac{\text{Pump Operating Hours} \times \text{Pump Flow Rate} \times 0.0022}{\text{Irrigated Area}}
\]

| Pump Operating Hours | 1505.0 | 13 hr |
| Pump Flow Rate       | 825    | 11 US gpm |
| Irrigated Area       | 170    | 1 acres |

\[
16.1 \text{ inches}
\]
Worksheet 9 Continued.

Method 3: Sprinkler system annual water use

<table>
<thead>
<tr>
<th>Sprinkler system output flow rate (max of boxes 5, 6 or 9 on Worksheet 7)</th>
<th>840</th>
<th>15</th>
<th>US gpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation Interval</td>
<td>15</td>
<td>16</td>
<td>days</td>
</tr>
<tr>
<td>Number of irrigations per year</td>
<td>4</td>
<td>17</td>
<td></td>
</tr>
</tbody>
</table>

**Equation:**

\[
\text{Annual Water Use} = \text{System Flow x Irrigation Interval x No. of Irrigations x 0.053 Irrigated Area}
\]

\[
= \frac{840 \text{ US gpm}}{15 \text{ days}} \times \frac{16 \text{ days}}{4 \text{ irrigations per year}} \times 0.053 \text{ acres} = \frac{170 \text{ acres}}{16 \text{ inches}}
\]

**Answer:** If there is a Water Licence, 3(a), and as a double check, do step 3(b).

If using ground water or if water supplied by a purveyor (no licence requirement), do step 3(b) only.

**Step 3(a).** Check annual water use with Water Licence.

Convert annual water use to acre-feet and compare to the licensed annual volume

**Equation**

\[
\text{Annual Water Use Acre-Feet} = \frac{\text{Actual Annual Water Use x Irrigated Area}}{12}
\]

\[
= \frac{16 \text{ inches x 170 acres}}{12} = \frac{228 \text{ ac-ft}}{19 \text{ ac-ft less than 262 \text{ ac-ft?}}
\]

**YES** Water licence is not exceeded

**Step 3(b).** Calculate percent difference of peak flow rate. Use the metered water use if available because it is the most accurate method.

**Equation**

\[
\text{Percent Difference} = \frac{\text{Actual Annual Water Use}}{\text{Calculated Annual Water Requirement}} \times 100\%
\]

\[
= \frac{16 \text{ inches}}{14 \text{ inches}} \times 100\% = \frac{114 \%}{20 \% \text{ less than 110\%?}}
\]

**NO** Refer to the 'Irrigation System Assessment Guide' to find ways to reduce water use
Worksheet #10  Annual Water Use Check - Trickle  Workbook Question 271

Question: A high density 14 acre apple orchard in Kelowna has a trickle irrigation system with a flow rate of 58 US gpm. The irrigation system consists of seven zones that have similar flow rates. Each zone operates for 2.5 hours per day. The system operated for 100 days during the irrigation season. A meter on the system indicates readings of 4,510,900 US gallons at the start of the year and 12,116,400 US gallons at the end of the year. Does the annual water use match the calculated annual irrigation water requirement for the farm?

Information:

<table>
<thead>
<tr>
<th>Irrigated area</th>
<th>14</th>
<th>acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated annual crop water requirement (select location)</td>
<td>Kelowna</td>
<td>19</td>
</tr>
<tr>
<td>Crop adjustment factor (select crop)</td>
<td>Tree Fruits – High Density</td>
<td>1</td>
</tr>
<tr>
<td>Application efficiency (select irrigation type)</td>
<td>Trickle</td>
<td>0.92</td>
</tr>
</tbody>
</table>

Calculation:

Step 1. Determine the calculated annual water requirement.

**Equation:**

\[
\text{Calculated Annual Water Requirement} = \frac{\text{Estimated Annual Crop Water Requirement} \times \text{Crop Adjustment Factor}}{\text{Application Efficiency}} \times 100\% \\
\]

\[
= \frac{19 \text{ inches} \times 1 \text{ 4}}{92 \text{ 5} \%} \\
= 21 \text{ inches} \\
\]

Step 2. Determine actual annual water use using one or more of the following methods:

Method 1: Metered water use

**Equation:**

\[
\text{Annual Water Use} = \frac{\text{Meter Reading at End of Year} - \text{Meter Reading at Start of Year}}{27027 \times \text{Irrigated Area}} \\
\]

\[
= \frac{12,116,400 \text{ US gal} - 100 \text{ US gal}}{27027 \times 14 \text{ acres}} \\
= 32 \text{ inches} \\
\]

Method 2. Pump water use

**Equation:**

\[
\text{Pump Power} = \text{Pump Horsepower from supplier's table} \times 0.746 \text{ KW/hp} \\
\]

\[
= 0 \text{ hp} \times 0.0746 \text{ KW/hp} \\
= 0.0 \text{ KW} \\
\]

**Equation:**

\[
\text{Pump Operating Hours} = \frac{\text{KWH for Entire Year}}{\text{Pump Power}} \\
\]

\[
= \frac{11 \text{ KWH}}{13 \text{ KW}} \\
= 0.846 \text{ hr} \\
\]
Worksheet 10 Continued.

**Equation:**

\[
\text{Annual Water Use} = \frac{\text{Pump Operating Hours} \times \text{Pump Flow Rate} \times 0.0022}{\text{Irrigated Area}}
\]

\[
= \frac{0.0 \times 14 \text{ hr} \times 0 \times 12 \text{ US gpm}}{14 \text{ acres}} = 0.0 \times 14 \text{ inches}
\]

**Method 3. Sprinkler system annual water use**

Sprinkler system output flow rate from Box 9 of Worksheet 8

**Equation:**

\[
\text{Annual Use} = \frac{\text{Zone Flow} \times \text{No. of Zones} \times \text{Operating Hours per Zone per Day} \times \text{No. of Operating Days per Year}}{\text{Irrigated Area}} 	imes 0.0022
\]

\[
= \frac{2.5 \times 16 \times 2.5 \times 18 \times 100 \times 19}{14 \text{ inches}} = 19.8 \times 20 \text{ inches}
\]

**Answer:**

If there is a Water Licence, 3(a), and as a double check, do step 3(b).

If using ground water or if water supplied by a purveyor (no licence requirement), do step 3(b) only.

**Step 3(a)** Check annual water use with Water Licence.

Convert annual water use to acre-feet and compare to the licensed annual volume

**Equation**

\[
\text{Annual Water Use Acre-Feet} = \frac{\text{Actual Annual Water Use} \times \text{Irrigated Area}}{12}
\]

\[
= \frac{32 \times 9, 15 \text{ or } 20 \text{ inches} \times 14 \text{ acres}}{12} = \frac{37 \text{ ac-ft}}{19 \text{ ac-ft?}}
\]

**Step 3(b)** Calculate percent difference of peak flow rate. Use the metered water use if available because it is the most accurate method.

**Equation**

\[
\text{Percent Difference} = \frac{\text{Actual Annual Water Use}}{\text{Calculated Annual Water Requirement}} \times 100\%
\]

\[
= \frac{32 \times 9, 15 \text{ or } 20 \text{ inches}}{155 \text{ inches}} \times 100\% = \frac{21 \text{ %}}{21 \text{ %}}
\]

**Refer to 'Irrigation System Assessment Guide' to find ways to reduce water use**
DRAINAGE

DRAINAGE ENVIRONMENTAL CONCERNS

Primary environmental concerns related to drainage systems are:
- disturbances during drain system installation and maintenance that results in impacts to water quality, aquatic life and habitat loss
- poor drainage discharge water quality that results in water pollution
- drainage discharge water quantity that results in increased watercourse flow and erosion

For information on these concerns:
- see Water Quality and Quantity Factors, page 9-1, and refer to all sections
- see Impacts on Biodiversity and Habitat, page 7-8, and refer to Farm Activities and Impacts

DRAINAGE LEGISLATION

The following is a brief outline of the main legislation that applies to drainage.
- see page A-1 for a summary of these and other Acts and Regulations

**Drinking Water Protection Act**

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).
- Section 6: requires water suppliers to provide potable water to water users
- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system

**Environmental Management Act**

The Code under the Agricultural Waste Control Regulation defines “watercourse” to include drainage ditches that flow into surface water such as a lake, river, creek, canal, etc.

**Water Act**

This Act and its Regulations require surface water use to be licensed and protects ground water. Drainage requires a licence for “land improvement purpose”. Approval is required for “works in and about a stream” such as open channels that allow water to flow into watercourses.
**Wildlife Act**  
The provincial *Wildlife Act* protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

**Fisheries Act**  
This Act has several sections of importance to drainage concerns:
- Section 35: prohibits harmful alteration, disruption or destruction of fish habitat unless authorized
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include drainage water)
- Section 37(4): requires approval for work that may impact fish habitat
- Section 38(4): requires reporting infractions of Sections 35 or 36

**Species at Risk Act**  
This Act has sections that protect listed species, their residence and critical habitat. It applies to federal lands, internal waters (i.e., all watercourses), territorial sea of Canada, and the air space above them.

The provisions of the Species at Risk Act (known as the ‘safety net’) could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

**DRAINAGE BENEFICIAL MANAGEMENT PRACTICES**

Comply with drainage legislation and, where appropriate, implement the following beneficial management practices.

Crops generally require moderately to well-drained soils for proper growth. Adequate drainage increases soil strength, trafficability and nutrient uptake by the crop. In the BC Interior, drainage serves the important added purpose of controlling soil salinity and alkalinity. In South Coastal BC, most soil and topographic conditions require subsurface drainage to reduce saturation of the crop root zone, to reduce soil compaction, to reduce overland flow and to control erosion.

Generally, improved subsurface drainage reduces overland flow, which in turn can reduce the potential transport of contaminants, including pesticides, fertilizers and soil particles, to surface waters.

**Drainage Systems**  
Plants growing in soils with good drainage are better able to take up nutrients from the soil and water, reducing leaching of nutrients. A drainage system may consist of a combination of land grading improvements, ditches, subsurface drainpipes and pumping systems. A site-specific design produced by a qualified soil and drainage specialist is highly recommended to ensure that subsurface systems are matched to specific soil conditions and plant rooting requirements. A well-designed system will improve the trafficability of soils, reduce the delay time for re-entry to fields after rainfall, and increase the growing season.
Implement the following practices:
♦ design subsurface drainage systems for the specific soil conditions and plant rooting requirements
♦ avoid the use of woodwaste as porous backfill around subsurface drains to prevent any potential of leachate contaminating drainage discharge water
♦ install interceptor drains to reduce concentrated overland flow
♦ grade land to eliminate low areas where water can pond to improve field access and trafficability (done in a manner that prevents soil degradation)
♦ grade land to reduce surface ponding (these are not wetlands but rather shallow depressions in a field) which attract unwanted wildlife such as ducks, thus avoiding further soil degradation from puddling by the ducks
♦ install permanent drop structures in channels to allow water to flow gently without causing erosion

Subsurface Drainage Systems. Maintenance of subsurface drains and outlets is important for the benefits of drainage. If relying on a subsurface drainage system to improve drainage and reduce surface flow as quickly as possible, any clogging of drains or obstruction of outlets will increase the potential for surface flows that could cause environmental problems.

Subsurface drainage can also be designed and operated to control the water table level within desired ranges. Some of the environmental benefits of controlled drainage are that:
♦ the system allows drainage water to be held back when drainage is not required, thus the subsurface drainage acts as subsurface irrigation, reducing water requirements and recycling nutrients that would otherwise leach out into the drain water
♦ drains can be closed if there is a potential for unwanted preferential flow
   ➔ see Preferential Flow, page 9-40
   ➔ Controlled Drainage/Subirrigation
   ➔ Maintenance & Checking of Performance of Subsurface Drainage Systems

Surface Drainage Systems. To maintain drainage ditches in a free-flowing condition, implement the following practices:
♦ keep grades shallow to reduce erosion
♦ slope ditch banks shallow enough to prevent slumping and erosion
  • sandy soils require shallower slopes than clay soils
♦ protect ditch banks, particularly those in sandy soils, against erosion with crushed rock, gravel or effective, permanent cover crops
  • grasses provide better cover than broadleaf weeds and reduce spread of weeds
♦ establish buffer strips to filter sediments before they reach the ditch
   ➔ see Buffers, page 11-4
♦ if despite of implementing the above, sediment and vegetation continue to restrict flow, then clean to remove materials as required to maintain flow
The following drainage information covers basic concerns. For more detailed information refer to the **Drainage Management Guide** publication, below.

**Drainage Management Guide** is a publication that forms part of the Environmental Farm Plan series on Beneficial Management Practices. Its purpose is to ensure drainage systems are operated and maintained in an environmentally correct manner. This publication contains more detailed information and is recommended for use by producers with surface drainage systems such as ditches, or with subsurface systems, that drain into areas with fish and fish habitat.

Guidelines have been established between agencies and producers for maintenance of agriculture watercourses, characterized by these steps:
- identify the drainage maintenance needs
- classify the watercourse
- review and determine the agency approval process for the type of work
- determine the timing window when the work will be done
- follow the required conditions for the watercourse and work to be done
- Regional up-to-date guidelines are available on the web.
  
  www.agf.gov.bc.ca/resmgmt/ditchpol/index.htm

**Agricultural Watercourse Classification.** Three watercourse classifications, as shown in Figure 9.3, below, are used to define agricultural watercourses. They are based on physical and hydrological parameters. The presence or absence of fish must also be determined.

- **constructed ditches**: have no headwaters, carry water from local surface areas or subsurface drains and may be permanently or intermittently wetted; such ditches are primarily constructed for the purpose of removing excess water from farmland in order to improve crop production and farm viability
- **channelized streams**: have headwaters, are permanent or relocated streams, often situated along property boundaries, that have been diverted, dredged, straightened and/or dyked
- **natural streams**: historic watercourses that have not been altered for extended periods of time,

  ![Agricultural Watercourse Classification](drainage-management-guide.png)

**Agency Approvals.** The classification of a watercourse and the type of work to be done in the watercourse determines the agency approval required. Approvals may be needed from Fisheries and Oceans Canada or MOE.

- **Agency Contact Requirements For Constructed Ditch Maintenance**
- **Agency Contact Requirements For Channelized And Natural Stream Maintenance**

**Timing Window.** An instream work ‘Timing Window’ is a time when fish species are at a stage in their life cycle when they are least sensitive to disturbances, such as may occur from maintenance work. These windows are set by the type of watercourse, its condition, and its location in BC.

Note: the above four are in the **Drainage Management Guide**
Drainage Water Quality

Quality of drainage water in watercourses can be degraded by surface contaminants reaching the drainage discharge through preferential flow pathways to drain tiles (see Preferential Flow, below), by overland flow to surface ditches, by woodwaste leachate used in constructing the drainage system, and by erosion at drain outlets.

Poor-quality drain water can be eliminated or controlled by implementing the following practices:

- keep contaminants from entering drainage systems
- install a controlled drainage system with the capacity of isolating and managing contaminated runoff
  
  → see Collecting and Storing Contaminated Water, page 9-44
  
  Controlled Drainage/Subirrigation

- plant a vegetative strip along the channel to filter contaminants before reaching the drainage system → see Buffers, page 11-4

Preferential Flow or Macropore Flow. Preferential flow occurs when holes or cavities created by worms, mice, or moles lead directly from the ground surface to subsurface drainage tiles, as shown in Figure 9.4, next page. In this situation, freshly-spread liquid manure may freely flow through the soil, into subsurface drainage tiles and from there to watercourses, causing a risk of pollution.
Where there is a risk of macropore flow, implement the following practices:
♦ do not spread manure on grass or bare fields when fields are wet and tile drains are running
♦ cultivate bare fields to break up macropores shortly before spreading manure (preferably within 24 hours)
♦ reduce one-time manure application rates to 40 m³/ha or less
♦ if contamination still occurs, it may be necessary to block the outflow or contain the contaminated drain water in a collection pond

![Preferred Flow Pathway via Macropores](image)

**Figure 9.4** Preferred Flow or Macropore Flow (Surface Water Flow Directly to Drain Tiles)

**Overland Flow.** Do not release contaminated runoff if it will cause pollution of any watercourse. Implement the following practices:
♦ stop the source of contamination
♦ capture (or be able to stop ditch discharge) and recirculate
♦ treat prior to discharge

**Woodwaste.** Monitor systems that were constructed in the past using woodwaste as backfill during the first few years to determine if woodwaste leachate in the drain water poses a pollution risk. Drainage water containing woodwaste leachate cannot be released into a watercourse. Avoid the use of such backfill as much as possible.

**Monitoring.** Monitor the water quality in drainage system outlets on a regular basis, particularly after a long dry spell and after manure has been applied. Such monitoring should determine if contaminants such as nutrients and pathogens are causing a pollution risk.

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*Water Quality Evaluation of Agricultural Runoff in the Lower Fraser Valley*
RUNOFF

For the purposes of this publication, stormwater originates as rainfall precipitation and is one source of runoff. Runoff (also called overland flow) is that portion of stormwater, snowmelt or irrigation water that moves across the land as surface water flow.

RUNOFF ENVIRONMENTAL CONCERNS

Primary environmental concerns related to runoff are:

♦ increased peak stream flow due to on-farm impervious areas that results in flooding downstream, erosion of stream banks, etc
♦ runoff water that becomes contaminated that results in pollution

For information on these concerns:

➔ see Water Quality and Quantity Factors, page 9-1, and refer to all sections
➔ see Impacts on Biodiversity and Habitat, page 7-8, and refer to Farm Activities and Impacts

RUNOFF LEGISLATION

The following is a brief outline of the main legislation that applies to runoff.

➔ see page A-1 for a summary of these and other Acts and Regulations

Local Bylaws

There may be local bylaws concerning stormwater management such as lot coverage or retention/detention pond construction details that need to be met.

Drinking Water Protection Act

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).

♦ Section 6: requires water suppliers to provide potable water to water users
♦ Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system
**Environmental Management Act**  
The Code under the *Agricultural Waste Control Regulation* has requirements for agricultural wastes that may be in runoff:

♦ Section 3: agricultural wastes must be collected, stored, handled, used and disposed of in a manner that prevents pollution
♦ Section 14: agricultural wastes must not be applied if runoff or escape of agricultural waste
  • causes pollution of a watercourse or ground water, or
  • goes beyond the farm boundary
♦ Section 30: agricultural products must be managed to prevent the escape of agricultural wastes (agricultural products include farm inputs and outputs)

**Fisheries Act**  
This Act has three sections of importance to runoff concerns:

♦ Section 35: prohibits harmful alteration, disruption or destruction of fish habitat unless authorized
♦ Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substance could include contaminated runoff)
♦ Section 38(4): requires reporting infractions of Sections 35 or 36

**Migratory Birds Convention Act**  
This Act has a section of importance to runoff concerns:

♦ Section 35(1): prohibits the deposit of any substance harmful to migratory birds in any waters frequented by migratory birds

---

**RUNOFF BENEFICIAL MANAGEMENT PRACTICES**

Comply with applicable runoff related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

Producers must ensure that the quality of surface water leaving or passing by the farm is not polluted by farm operations. The most effective practice in preventing water pollution is to eliminate runoff flows from contacting sources of contamination, such as manure. This is often done by diversion of runoff away from these sources, such as upland flow ditched away from yards, or roof water directed away using gutters.

**Runoff Flow Factors**  
The velocity and volume of runoff flows are affected by:

♦ the length and grade of a slope
♦ the aspect or direction a slope faces
  • south facing slopes can have quick snow melt events
♦ the soil surface texture which affects the smoothness of terrain
♦ the type of crop or volume of crop residue which also affects the smoothness of terrain

**Runoff Flow Management**  
**Stormwater Peak Flow.** Stormwater originates from rainfall events. Where development on a farm has increased the impermeable areas of roofs and hard-surface roads to greater than 10% of the total land area or 2 ha (suggested), manage stormwater to reduce flows to pre-development levels. On-farm detention ponds are most commonly used to reduce such peak flows.
Snowmelt. Snowmelt runoff risk is increased in the presence of fine-textured soils, frozen soils and low crop residue levels. Also, the risk is higher for south-facing slopes and increases as slopes increase in steepness and length. Limit the amount of agricultural waste spread on land in the fall, where the risk of snowmelt runoff is high.

see Tables 6.11 and 6.12, Monthly Manure Spreading Practices, pages 6-21 and 6-22

Preventing Surface Water Contamination. If runoff water becomes polluted it must be managed as contaminated water. Because the treatment of contaminated water typically entails considerable effort and expense, it is usually preferable to prevent the generation of contaminated water in the first place. Use the following principle:

Keep clean water away from sources of contamination;
Keep sources of contamination away from clean water

To protect surface water quality, implement the following practices:
♦ reduce the volume of contaminated water to be collected by using perimeter diversion ditches to divert clean runoff around outdoor livestock areas, manure, woodwaste, pesticide and fertilizer storage areas, wells and springs
♦ construct impermeable berms to prevent water that has become contaminated from entering watercourses
♦ reduce the amount of runoff water by
  • planting cover crops to improve the infiltration rate of water
  • ensuring that subsurface drainage systems work as designed
♦ establish and maintain adequate vegetative buffers around watercourses to
  • keep suspended or dissolved contaminates from causing pollution
  • reduce nuisance impacts on neighbours
  • intercept quantities of runoff
see Buffers, page 11-4

Contaminated Water Collection, Storage and Use

Water may contain farm contaminates such as manure, soil, pesticides, petroleum and fertilizer. Contaminated water must be handled as a pollutant unless found not to be an environmental concern. To determine the impact of such water entering watercourses, samples may need to be collected upstream and downstream of the source of the runoff for laboratory analysis. Contact the water-testing laboratory to find out how to collect representative samples. For help to determine if contaminated water is negatively affecting stream water quality and polluting, various criteria must be examined.

British Columbia Approved Water Quality Guidelines

Water Quality Evaluation of Agricultural Runoff in the Lower Fraser Valley

http://www.env.gov.bc.ca/wat/wq/

Collecting Contaminated Water. Implement the following practices to collect contaminated water from these three common sources:
♦ from outdoor areas, use berms or grade the area with a 2 to 4% slope to direct water to run into a collection basin or manure pit for reuse (take this extra volume into account when sizing manure pits)
♦ from drainage systems, be able to isolate and close the drainage system to store water
♦ from irrigation runoff, divert surface runoff to a reservoir for reuse and improve the irrigation system

**Storing Contaminated Water.** Contaminated water that cannot be immediately used must be stored in a secure facility until it can be disposed of or used in an environmentally sound manner. For example, it would not be unusual that some winter and spring runoff originating from confined livestock areas would be contaminated. Storage in such cases is essential until the waste can be properly applied to cropland in the spring or summer.

Depending on soil conditions, contaminated water storages may be earth lined if in clayey areas; in coarser soils impervious materials such as plastic or concrete will be required. Siting considerations are similar to those for manure storages:
♦ locate storages away from ditches, wells and watercourses
  • at least 15 m from a watercourse (Agricultural Waste Control Regulation)
  • at least 30 m from domestic water source (Agricultural Waste Control Regulation)
  • at least 30.5 m from wells (Public Health Act)
⇒ see Manure Storage – Storage Facilities, page 3-23

**Sizing Contaminated Water Storage.** Contaminated water must be stored to avoid application on snow or frozen ground. Under most Southern BC conditions, storage is required during the six months of October to March inclusive. In Northern BC, a minimum seven months of storage, October to April inclusive is recommended to accommodate the shorter season available for spreading. Appendix Table B.1, page B-3, shows the six and seven month precipitation values for areas of BC. Where appropriate, retain the services of a hydrologist to ensure proper sizing of a storage facility.

The size of a collection basin for contaminated runoff depends on:
♦ the amount of precipitation that occurs during the storage period
♦ the farm area directly influenced by contamination material
♦ the type of ground cover on the drainage area
♦ the amount of offsite runoff entering a contaminated area

To obtain a first approximation for design of storage of contaminated runoff from outdoor livestock areas (where no offsite surface water enters the area), use Worksheet #11, page 9-47:
♦ design storage capacity is based on the most winter precipitation expected in 25 years (recommended)
♦ the winter storage period (either 6 or 7 months) depends on when the storage can be emptied in the spring
♦ during the growing months of May to October, sizing considerations do not come into play as contaminated runoff can be directly applied to cropland
Using Contaminated Water. If contaminated runoff has been collected it must be disposed of so as not to pose a pollution risk to humans, livestock or water quality. The specifics of disposal depend on the types of contaminants in the water. Contact the MOE if you are uncertain of appropriate disposal method.

If the contaminant is manure or fertilizer, spread the affected water onto cropland as outlined in Nutrient Application, page 6-8.

If the contaminant is woodwaste, spread the affected water onto cropland that readily allows infiltration. Woodwaste leachate should travel through at least 60 m (suggested) of soil prior to entering surface or ground water.

If the contaminant is mainly eroded soil, settled solids may be applied to land, with the remaining liquid applied as irrigation water.

If the contaminants are petroleum and pesticides, test the water for the degree of contamination. If resulting quality standards are not met, treat the water before reuse or release.

- Water Quality Evaluation of Agricultural Runoff in the Lower Fraser Valley
- Guidelines for Canadian Drinking Water Quality
A farm in Abbotsford has a 300 m² hard-surfaced livestock yard. What volume of contaminated water will need to be stored over the winter?

### Information:

- **Area of confined livestock site:** 300 m²
- **Type of surface:** Hard surface, frozen land or roof
- **Total Winter Precipitation:** 1.54 m
- **Select site:** Abbotsford

### Calculation:

Calculate storage area for type of yard surface

**Method 1. For hard surface, frozen land or roof areas**

\[
\text{Volume} = 1.0 \times \text{Area} \times \text{Total Winter Precipitation} = 1.0 \times 300 \text{ m}^2 \times 1.54 \text{ m} = 462 \text{ m}^3
\]

**Method 2. For soil based yards**

\[
\text{Volume} = 0.9 \times \text{Area} \times \text{Total Winter Precipitation} = 0.9 \times 300 \text{ m}^2 \times 1.54 \text{ m} = 416 \text{ m}^3
\]

**Method 3. For crop land (not frozen)**

\[
\text{Volume} = 0.6 \times \text{Area} \times \text{Total Winter Precipitation} = 0.6 \times 300 \text{ m}^2 \times 1.54 \text{ m} = 277 \text{ m}^3
\]

### Answer:

This farm will require a contaminated water storage facility to hold 462 m³ of contaminated water expected from the outside yard area.
LEACHATE

Leachate is produced from water moving through a material, such as woodwaste or manure, creating a contaminated liquid. Leachate can move over the soil surface to surface water or through the soil to ground water.

LEACHATE ENVIRONMENTAL CONCERNS

Primary environmental concerns related to leachate are:
contamination reaching ground water or surface water that results in water pollution

For information on these concerns:
➔ see Water Quality and Quantity Factors, page 9-1, and refer to all sections

LEACHATE LEGISLATION

The following is a brief outline of the main legislation that applies to leachate.
➔ see page A-1 for a summary of these and other Acts and Regulations

Drinking Water Protection Act
This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).
♦ Section 6: requires water suppliers to provide potable water to water users
♦ Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system

Environmental Management Act
The Code under the Agricultural Waste Control Regulation has a general reference to preventing pollution:
♦ Section 3: agricultural wastes, woodwaste and mortalities must be collected, stored, handled, used and disposed of in a manner that prevents pollution
♦ Section 12: agricultural wastes must be applied to land only as a fertilizer or soil conditioner

Public Health Act
This Act has prohibits a person from willingly causing a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard.
♦ Section 18: provides separation distance of wells to be at least 30.5 m from any probable source of contamination
**Fisheries Act**  This Act has two sections of importance to leachates:

- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include leachates)
- Section 38(4): requires reporting infractions of Section 36

### LEACHATE BENEFICIAL MANAGEMENT PRACTICES

Comply with applicable leachate related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

#### Leachate Sources

Leachate can be generated from water moving through any material that contains soluble components or degrades or decomposes in the presence of water. Materials that can be sources of leachate can be split into two broad classes, those that are mainly organic (e.g., woodwaste, silage, manure, and compost), and those that are mainly inorganic (e.g., fertilizer, pesticides and farm waste). In general, the more rapidly a material releases soluble compounds (or nutrients) to water the greater the risk of an environmental impact. For more information on the sources of material that may produce leachate, see the following sections:

- see Farm Waste, page 2-13
- see Chemical Fertilizer, page 2-18
- see Woodwaste, page 2-27
- see Compost, page 2-32
- see Manure, page 3-21
- see Mortality Disposal, page 3-37
- see Forage Crop Storage, page 4-10
- see Greenhouse, Container Nursery and Mushrooms, page 4-12
- see Pesticides, page 5-11
- see Leachate Formation in Soil, page 8-14

#### Leachate Production Factors

Figure 9.5, below, illustrates factors that influence the volume and quality of leachate production and its movement to surface water and ground water:

- water moving through materials or the soil will produce and move leachate
  - high precipitation areas are most at risk, such as the Pacific Coast climatic region (Climatic Information, page B-1)
- structures or farm layout design that
  - keep water from coming in contact with materials will reduce the risk of leachate production
  - have leachate containment
- the type and moisture content of materials through which water percolates
- the pH of water movement in soil
- the degree of leachate capture via soil adsorption
  - see Leachate Movement in Soil, page 9-50
- the degree of leachate capture in crop uptake

Reduction of leachate production and methods to address management of materials can be found in Chapters 2-6.

- see Woodwaste, page 2-27, see Compost, page 2-32
- see Manure, page 3-21, see Forage Crop Storage, page 4-10
- see Mushroom, page 4-17
Leachate Pollution Risk

The threat leachate poses in its ability to cause pollution depends on several factors:

- leachate formation or contaminant solubility (how well the chemicals being leached dissolve in water)
- leachate contaminant capture
  - absorption (whether it will bind to soil particles)
  - crop uptake (whether crop can utilize the dissolved chemicals)
  - degradation (whether it changes characteristics as it is exposed to the soil)
- leachate movement to surface or ground water
- leachate quantity

Leachate Movement in Soil

The degree of movement of leachate in soils is a function of:

- soil infiltration and permeability, and soil capacity to bind contaminants
  ➔ see Contaminant Movement in Soil, page 8-15
- soil water content

Water Content. The movement of water through the soil is the primary mechanism which moves leachate through the soil. In order to reduce this movement, implement the following practices:

- design and manage irrigation systems to avoid over-application of water
- avoid the use of soil amendments in fields that generate leachate that will cause pollution, if water is moving downward to ground water
- design and manage subsurface drainage systems to capture and treat contaminated water, particularly if macropore flow is estimated to be a risk ➔ see Drainage Water Quality, page 9-40

Leachate Capture in Soil

Nutrients and metals in leachate have the potential to be captured in the soil by adsorption or by uptake into plant roots. Effective use of nutrients can be achieved by collecting leachate in a holding pond for subsequent use as irrigation water on cropland.

Soil Adsorption. If leachate has entered the soil, the possibility for natural “entrapment” or “treatment” by the soil exists. Some leachate will react with the soil and be neutralized, while acidic leachate, for example, has the potential to dissolve and mobilize metals or other substances to create a more hazardous situation. Soil processes such as adsorption, which are dependent on soil pH, organic matter or clay content, can neutralize or capture leached chemicals. Whereas woodwaste leachate, acidic by nature, should travel long distances through soil prior to entering surface water or ground water (more than 60 m, suggested).
Figure 9.5  Leachate Production, Movement and Environmental Risks
Crop Uptake. If leachate reaches the root zone, the possibility for plant utilization of the dissolved nutrients exists. In order to increase the capture of such nutrients, implement the following practices:

♦ plant cover crops such as annual ryegrass relay crops on corn land to capture nutrients which become available after cash crop uptake ceases
♦ design and manage subsurface drainage systems to increase the size of the crop root zone available for nutrient capture
♦ establish and maintain adequate vegetative buffers to capture leachate moving through the soil to surface or ground water

⇒ see Buffers, page 11-4

Contaminant Degradation. Chemicals introduced into soil by agricultural practices such as pesticides or petroleum will naturally degrade to some extent over a variable period of time due to the chemical and biological activity of soil.

Leachate Control

The best alternative to deal with leachate problems is to prevent leachate generation at the onset. Cover leachable materials with tarps or roofs to prevent water from contributing to the formation of leachate.

Leachate Containment. If leachate is generated, containment is the best control method. Implement the following practices:

♦ contain leachate near its source by ensuring the existence of an impervious barrier between potential leachate sites and the soil (e.g., a concrete pad under stored material)
♦ construct a containment area sized to hold all leachate produced

Leachate Capture. If leachate cannot be contained, capturing it is the only, often difficult, means to prevent it from reaching surface water or ground water. Implement the following practices:

♦ capture leachate runoff by
  • constructing berms and ditches to direct it to storage
  • planting buffers to capture contaminants ⇒ see Buffers, page 11-4
♦ store captured leachate in an impervious storage

Leachate that has been contained or captured must be handled and disposed of such that the specific contaminants in it do not pose a pollution risk. In some cases, it is entirely appropriate to recycle leachate as, for example, through irrigation systems in greenhouses or nurseries.

⇒ see Collecting and Storing Contaminated Water, page 9-44

Leachate Use

Leachate collected from sources such as silage, manure or compost can effectively be used as a nutrient source.

⇒ see Nutrient Application, page 6-8

Leachate Treatment. If leachate cannot be used in an environmentally sound manner, treat it prior to discharge. Treatment options include biological treatment in lagoons or constructed wetlands, activated carbon adsorption (a filtering method), and other chemical technologies. Most treatment technologies, because they are typically costly to implement, should be avoided where possible. Regardless of the type of treatment, any discharge requires a permit from the MOE.
This chapter has outlined environmental impacts that may occur to water from a farm operation. However, some operations may be affected by impacts from water.

**WATER CONFLICTS CONCERNS**

Three primary water conflicts can pose major impacts to farms:
- Excess water that results in flooding from:
  - runoff water entering the property
  - surface water flooding from streams or lakes
  - ground water flooding from a rise in water tables
- Insufficient water that results in:
  - reduced access to surface or ground water sources
  - drought from seasonal or climate changes
- Water quality that is unfit for domestic, livestock or irrigation uses

**WATER CONFLICTS LEGISLATION**

**Fish Protection Act**
The *Fish Protection Act* enables the protection of fish and fish habitats. Four main objectives of the Act are to ensure sufficient water for fish, enable fish habitat to be protected and restored, improve riparian habitat protection and enhancement, and to give local governments greater powers for environmental planning.
- Section 9: In the case of drought, for the purposes of protecting the fish population, the minister may make temporary orders regulating the diversion, rate of diversion, time of diversion, storage, time of storage and use of water from the stream by holders of licences or approvals in relation to the stream.

**Water Act**
The *British Columbia Dam Safety Regulation* is to mitigate loss of life and damage to property and the environment from a dam breach by requiring dam owners to: inspect their dams, undertake proper maintenance, report incidents and take remedial action and ensure that the dams meet current engineering standards.
Comply with any related legislation and, where appropriate, implement the following beneficial management practices to protect the environment.

**Flooding From Stormwater or Runoff Water**

Stormwater or runoff water associated with agricultural conflicts typically originates from surrounding properties and may be contaminated. Neighbouring farm properties should complete and implement an environmental farm plan. Where this is not possible, manage the stormwater to minimize environmental impacts.

Upland urban stormwater management is critical to protect low farm land.

- see Farm Building Siting, page 2-4

**Flooding From Watercourses**

While dyking is intended to protect land from flooding, it also removes that same land as a floodplain buffer for a given watercourse. This may cause downstream impacts such as bank erosion because flows are unable to be reduced by natural spilling onto the floodplain. A farm’s flood protection measures may become another farm’s bank erosion problems. Consult the MOE, Fisheries and Oceans Canada, and local community flood plans before measures to redirect floodwaters are undertaken. Where appropriate, flooding from neighbouring properties should be addressed in the neighbouring properties Environmental Farm Plan.

- see Water Conflict Contingency Plan, next page.

**Dam Inspection and Maintenance**

Failure of water storage structures, such as dams used for irrigation or stock watering, can result in negative impacts to water quality, downstream habitat and farmland. Regular inspection and maintenance of dams is important in order to detect weakness in the dam before failure occurs. The responsibility to inspect and maintain privately owned dams falls on the dam owner. For more information the requirements of dam owners to inspect and maintain their dam, visit [http://www.gov.bc.ca/fortherecord/safety/](http://www.gov.bc.ca/fortherecord/safety/)

**Drought**

In many cases reduced irrigation water availability can be expected if reservoirs are low in the spring or if a low snowpack levels warn of impending reduced watercourse flows in the subsequent growing season. Good water management in such conditions is more important than ever.

The MOE has implemented a four stage drought response system that can restrict water use during periods of drought. Table 9.6 describes the four stages of drought response and the corresponding potential water use restrictions to agricultural producers.
<table>
<thead>
<tr>
<th>Stage</th>
<th>Goals</th>
<th>Actions Effecting Agriculture</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Normal</td>
<td>Prevent entrance to Dry Stage</td>
<td>Preparedness – planning</td>
<td>Ongoing reductions in community water use</td>
</tr>
<tr>
<td>2 Dry</td>
<td>Prevent and prepare for Very Dry</td>
<td>Voluntary conservation – recommend changes in practices (cropping and water use)</td>
<td>Minimum 10% reduction (up to 20%)</td>
</tr>
<tr>
<td>3 Very Dry</td>
<td>Prevent and prepare for Extremely Dry</td>
<td>Voluntary conservation and restrictions – possible reduced availability from supply – Province may limit the number of, and impose restrictions on, new licences, regulate storage, or invoke conditions on existing licences</td>
<td>Minimum additional 20% reduction (up to 40%)</td>
</tr>
<tr>
<td>4 Extremely Dry</td>
<td>Prevent and prepare for possible loss of supplies, maximum possible reductions for all sectors</td>
<td>Voluntary conservation, restrictions and regulatory response - Province may restrict use by lower priority licensees or those with conditional clauses, may assist communities seeking alternative sources</td>
<td>Maximum reduction</td>
</tr>
<tr>
<td>Loss of Supply</td>
<td>Ensure health and safety</td>
<td>Potential loss of a community’s potable or fire fighting water supply</td>
<td>Emergency water use only</td>
</tr>
</tbody>
</table>

Implement the following practices in drought conditions:
- minimize water consumption
- develop out-of-channel water storage and collect runoff flows
- increase efficiency of water use by
  - using soil moisture measurements to schedule irrigation
  - checking all water systems for leaks and other avoidable losses
  - checking sprinkler nozzles and replacing worn units
- make use of industry crop specialists for specific water management recommendations that will make the best use of available irrigation water
  - see Irrigation, page 9-18

- Irrigation Tips to Conserve Water on the Farm
- Key Drought Management Tips

**Water Quality** If a source of farm water is in danger of being or has been degraded because of off-site impacts, implement the following practices to reduce conflicts:
- if possible, locate the source of contamination and put into place measures to reduce or eliminate the contamination
- if practical, treat the water before use
- contact the MOE to investigate any man-made sources of pollution and have the pollution stopped
- change irrigation practices to compensate for poor water quality by, for example, over irrigating to leach out accumulated salts

**Water Conflict Contingency Plan** Develop a contingency plan to provide a timely and effective response to any emergencies involving the farm operation, such as obtaining pre-approval from agencies to do changes in or about a stream to protect farmland during flooding emergencies.  
- see Changes In and About a Stream, page 7-16
- Contingency Plan – Template for On-Farm Planning
### CHAPTER 10 METRIC CONVERSIONS

<table>
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<th>Imperial Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 µm</td>
<td>1/10,000 inch</td>
</tr>
<tr>
<td>4 m</td>
<td>13 feet</td>
</tr>
<tr>
<td>100 m</td>
<td>330 feet</td>
</tr>
<tr>
<td>500 m</td>
<td>1,650 feet</td>
</tr>
<tr>
<td>1 km</td>
<td>0.6 mile</td>
</tr>
</tbody>
</table>

Conversions in this table are rounded to a convenient number. See Appendix E for exact conversion factor.

Values from tables and examples are not included in Metric Conversions.
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INTRODUCTION

This chapter discusses beneficial management practices for protection of air quality. It contains introductory information on the relationship between agriculture and air quality. It also contains information on concerns, legislation and beneficial management practices related to:

- air emissions
- dust and particulate
- odours
- open burning

AIR CONTAMINANTS

The key air contaminants that define air quality are gaseous emissions, dust and particulates. These contaminants can have an impact on human health and the environment as well as contribute to climate change.

The following air contaminants are listed in alphabetical order. While air quality can be influenced by agricultural production, it also may be influenced by many other human activities and natural phenomena.

Ammonia (NH₃). Ammonia easily volatilizes from urine, manure, fertilizer, compost and crop residues. Agriculture is the largest emitter of ammonia to the air both in BC and globally. Ammonia contributes to reduced visibility by reacting with other chemicals in the air to form secondary particulate matter, (i.e. ammonium sulphate and ammonium nitrate). These compounds are a major component of fine particulate matter in the air of the Fraser Valley. Elevated levels of fine particulate can reduce visibility and are a concern to human health.

Carbon Monoxide (CO). Carbon monoxide originates mainly from the combustion of fuels used to heat buildings and greenhouses, and from farm equipment (both biomass and fossil fuels). The effects of carbon monoxide tend to be localized; at high concentrations the gas can cause asphyxiation, and at lower levels it produces symptoms of impaired perception and reflexes. Carbon monoxide also contributes to smog formation, but to a much lesser degree than nitrogen oxides or volatile organic compounds.
Nitrogen Oxides (NOx). Nitrogen oxides aid in the production of ground level ozone, a known respiratory irritant and crop growth retardant. Nitrogen oxides also contribute to acid rain production. Nitrogen oxides like carbon monoxide and sulphur oxides originate mainly from the combustion of fuels used to heat buildings and greenhouses, and from farm equipment (both biomass and fossil fuels).

Ozone (O3). Ozone is unique among the atmospheric gases in that in the upper layers it is highly beneficial whereas near ground level it is a serious pollutant. Ground-level ozone is primarily formed by the reactions of other pollutants such as nitrogen oxides and volatile organic compounds. Both ground-level ozone and particulates contribute to smog formation which has detrimental effects on the human cardio-respiratory system and on crop productivity. Human caused emissions have tended to deplete ozone in the upper atmosphere while increasing its concentration at ground level.

Sulphur Oxides (SOx). Sulphur oxides originate mainly from the combustion of fuels (both biomass and fossil fuels) used to heat buildings and greenhouses, and from farm equipment. Sulphur dioxide (SO2) can damage vegetation and can have negative effects on the human cardio-respiratory system. Sulphate (SO4^{2-}) reacts with other chemicals in the air to form, among other things, ammonium sulphate which contributes to acid rain and is also a major component in the formation of fine particles within the atmosphere.

Volatile Organic Compounds (VOC). Volatile organic compounds are released from various types of manure, petroleum products, and some types of pesticides. Many volatile organic compounds and nitrous oxides aid in the production of ground level ozone, a known respiratory irritant and crop growth retardant. Volatile organic compounds can be a source of odours and also contribute to the formation of fine particulate matter, causing health and visibility concerns.

**Dust and Particulate**

Particulates are very small particles in the air. Coarse particles are defined as being greater than 2.5 µm in diameter, and are created primarily from natural or mechanical processes. Fine particles are 2.5 µm or less in diameter and are typically produced in chemical reactions.

Examples of coarse particulates include dust from livestock operations, cultivation, crop operations, crop harvest, and road dust. Examples of fine particulates include ammonium nitrate and ammonium sulphate, formed in reaction with other air pollutants, typically seen as the white haze common to the Fraser Valley under specific weather conditions. Once air borne, particulates may drift for very long distances and can stay in the atmosphere for days.

Specific health problems associated with exposure to fine particulates include aggravation of respiratory and cardiovascular disease, reduced lung function, increased respiratory symptoms and premature death.

**Greenhouse Gases**

When the sun’s rays strike the earth, light energy is converted into heat energy which in turn is radiated back into the atmosphere. Certain gases called ‘Greenhouse Gases’ (also known as Global Warming Gases) absorb some of this heat energy, resulting in a warming of the earth’s atmosphere. This is known as the greenhouse effect. Greenhouse gases such as carbon dioxide,
methane, nitrous oxides and other gases are discharged by many human activities, including agriculture.

**Carbon Dioxide (CO₂).** Carbon dioxide is a greenhouse gas produced by the combustion of fossil fuels and biomass. Carbon dioxide is a major contributor to the greenhouse effect and is therefore associated with climate change. Trees, vegetation and soil organic matter can remove carbon dioxide from the atmosphere and store as carbon.

**Methane (CH₄).** Methane is a greenhouse gas produced during anaerobic decomposition (decomposition in the absence of oxygen) of organic wastes such as manures. Animals, particularly ruminants, emit methane gas that contributes to the greenhouse effect.

**Nitrous Oxides (N₂O).** Nitrous oxide is a greenhouse gas produced in the soil from the biochemical reduction of nitrate to gaseous nitrogen compounds, a process known as denitrification.

## IMPACTS ON AIR QUALITY

**Heat Production and Agricultural Boilers**

Heat is used in greenhouse production, animal housing and for general space heating. Traditional fuel sources for boilers include natural gas and in some cases, coal. These fuel sources are being replaced by biomass and subsequently new regulations that set standards for air quality have been implemented. Burning biomass in boilers produces particulate matter (PM), CO₂ and other air contaminants. There are several ways to reduce the impact of biomass boilers with emission control technology and beneficial management practices.

→see Heat Production and Agricultural Boilers, page 2-39

**Indoor Poultry and Livestock Housing**

Indoor poultry and livestock housing can have either natural or forced ventilation systems that help circulate air within the animal housing area. Both ventilation systems contribute to PM and NH₃ emissions, as well as odour that occurs outside of the animal housing area. In animal facilities, ammonia results primarily from the breakdown of manure. Undigested feed protein and wasted feed are additional sources of ammonia in animal production systems. Strategies to reduce ammonia from animal housing focus primarily on preventing ammonia formation and volatilization, or downwind transmission of ammonia after it is volatilized.

→see Indoor Poultry and Livestock Housing, page 3-2

**Manure Handling and Storage**

The main pollutants associated with the production and handling of manure are methane (CH₄), ammonia (NH₃) and nitrous oxide (N₂O). Methane is produced under anaerobic conditions during the microbial breakdown of organic compounds in manure. Manure handled as liquid or slurry will emit methane. Manures handled as a solid will have a lesser moisture content and will emit less methane if kept dry. Ammonia is produced in the decomposition of the organic nitrogen compounds in manure. Methane and ammonia are present during both storage and handling of manure. N₂O emissions occur mainly from manure application to soils. N₂O emissions will be significant if the manure is first handled dry and then handled wet. VOCs are also formed from the breakdown of manure both anaerobically and aerobically.
Noise

For the purposes of this publication, noise is considered a nuisance, not an environmental concern. Noise generated by farm activities has the greatest potential for creating nuisance in densely populated areas where farm sites are developed near property boundaries.

Nutrient and Chemical Applications

Pathogens. Many organic wastes, including manures, contain micro-organisms such as bacteria, viruses and parasites. Some of these micro-organisms may be pathogenic (disease causing) to animals of the same or of a different species. Many diseases are transmissible between animals and human beings. Most pathogens die off rapidly when dried or exposed to sunlight. However, there are some that can remain infectious in the air over extended distances and periods of time.

Pesticides. Pesticides include insecticides, herbicides, fungicides and rodenticides. The application of pesticides can result in the formation of spray droplets, mists, or dusts. These airborne particles are prone to drift and can be transported over many kilometres to contaminate other properties. In addition, these pesticide particles may be hazardous to non-target organisms. Applicators and workers may be affected if restricted entry intervals as specified on labels are disregarded.

Active ingredients within some pesticides are volatile and can evaporate from target areas and move with air currents to unwanted locations.

Odours

The handling, storing and composting of wastes; the application of manure and pesticides; and the decomposition of crop wastes can create odours that are offensive to neighbours. Odours, which are generated by farming activities in compliance with the Code under the Agricultural Waste Control Regulation and with the practices outlined in this publication, should be considered nuisances rather than health hazards.

Open Burning

Open burning produces many harmful air emissions. Smoke from the open burning of vegetation and wood introduces a range of contaminants into the air, including particulate matter, carbon dioxide, carbon monoxide, nitrogen oxides, and hydrocarbon compounds.

Ash and dust particulates are introduced into the air mainly by open burning of plant prunings and other similar materials. Fly ash, a term for the larger particulates in burning emissions, can create aesthetic concerns and nuisance complaints. Open burning of plastics and other specific wastes as defined by the Open Burning Smoke Control Regulation is prohibited and produces many harmful air emissions that can cause localized environmental problems and health impacts.
Primary environmental concerns related to air emissions from agriculture are:

- pollution caused by fossil fuel combustion, wood burning, livestock emissions, waste disposal, soil emissions, and manure handling which results in the following:
  - release of ammonia (NH₃), sulphur oxides (SOₓ), volatile organic compounds and nitrogen oxides (NOₓ) which can chemically produce secondary particulate which poses a risk to human health and reduces visibility
  - release of volatile organic compounds (VOCs) and nitrogen oxides (NOₓ) (i.e. manure, petroleum) that create ground level ozone and lead to the formation of smog which is a concern to human and vegetative health.
  - release of greenhouse gases, mainly carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O), which are linked to global climate change

This chapter addresses environmental concerns related to poor air quality, whereas Chapter 12 addresses environmental concerns related to climate change. Poor air quality and climate change are different phenomena, but the emission sources for both of these environmental issues are similar. Taking actions to reduce the pollution from agricultural sources will help improve air quality and address climate change.

For information on these concerns:

- see Air Quality Factors, page 10-1, and refer to Contaminants, and Greenhouse Gases
- see Impacts of Agricultural Activities on Greenhouse Gas Emissions, page 12-6
The following is a brief outline of the main legislation that applies to air emissions.

→ see page A-1 for a summary of these and other Acts and Regulations

**Local Bylaws**
Regional and municipal governments can pass bylaws to control emissions such as backyard and open burning, wood stoves and vehicle idling. These governments can also address air pollution through land-use and transportation planning, regional growth strategies and sustainability plans. Local Governments can put in place bylaws that restrict air emissions from industrial and business operations.

**Environmental Management Act**
This Act provides the Ministry of Environment with the authority to manage, protect and enhance the environment.

The Code under the *Agricultural Waste Control Regulation* has two references to air emissions:
- Section 17: states that emissions from forced air ventilation systems must not cause pollution
- Section 18: regulates type of fuel and emissions from wood fired boilers used in agricultural production
- Sections 18.1 – 18.6 set emission standards, testing and reporting requirements for boilers and heaters fuelled by biomass

Under the Environmental Management Act, local governments may be delegated authority to manage air quality within their boundaries. For example, Metro Vancouver has been delegated authority to manage air quality within its boundaries. It administers laws that regulate emissions from industrial, commercial and industrial sources, through permits, compliance promotion and enforcement.

The Act also enables the Province to regulate the emissions from industrial and business operations through the issuance and enforcement of air emission permits.

The *Open Burning Smoke Control Regulation* governs smoke from open burning of vegetative debris from the forestry industry, agriculture sector, land developers and individual property owners. It sets conditions such as setbacks, smoke release periods and venting conditions that must be met.

**Motor Vehicle Act**
The *Motor Vehicle Act* is administered by the Ministry of Transportation and Infrastructure and requires emission control devices on certain heavy diesel vehicles in the province.

As of October 1, 2010, in accordance with the *Motor Vehicle Act*, heavy diesel vehicle emission control devices must be installed on all BC registered commercial diesel vehicles of model years 1989-1993 with a Licensed Gross Vehicle Weight (LGVW) of more than 8,200 kg. Farm vehicles with a LGVW under 17,300 kg are exempt from these retrofit requirements.
The federal government’s role in addressing air quality issues is defined through the *Canadian Environmental Protection Act*. Many emission sources that lie beyond provincial authority are subject to federal regulation, standards and guidelines. These include motor vehicles and fuels, marine vessels, railways and off-road engines applicable to agricultural vehicles.

The *Off-Road Compression-Ignition Engine Emission Regulation* introduces emission standards for diesel engines used in off-road applications such as those typically found in construction, mining, farming and forestry. Emissions from engines used in agriculture that are newer than 2006 are subject to the Regulation.

> see Climate Change Legislation, page 12-8
> see page A-1 for a summary of these and other Acts and Regulations

**AIR EMISSION REDUCTION BENEFICIAL MANAGEMENT PRACTICES**

Proper management of manure, crops, nutrients and machinery will greatly assist in reducing pollution causing air emissions from farm operations. Poor air quality and climate change are different phenomena, but their causes are similar. Taking actions to reduce the pollution from agricultural sources will help improve air quality and address climate change.

Comply with applicable air emission related legislation, including the above, and where appropriate, implement the following beneficial management practices to reduce air emissions from agriculture.

Table 10.1 outlines some common farm practices and the resulting air emission(s). The table will help to determine the positive impact that the following beneficial management practices will have on reducing air emissions from agriculture.

Implement the following practices to reduce air emissions:

- maximize the use of renewable energy, such as electricity, wind or solar
  > see Climate Change Mitigation Beneficial Management Practices, page 12-10, and refer to On-Farm Energy Production
- use energy-efficient equipment and operating practices
- use high efficiency motors and pumps
- use efficient irrigation equipment to reduce pumping energy requirements
- maintain engines in efficient running order
- use energy saving practices to reduce fuel usage by farm machinery
  - avoid unnecessary idling
  - keep tires inflated at optimum tire pressure
  - graze livestock rather than growing forages that require transport to separate feeding areas or feedlots
  - reduce tillage and therefore reduce the use of machinery and the fossil fuel used for equipment
- keep internal combustion engines well maintained and include emission control devices if necessary (such as air filters, diesel injectors or catalytic converters)
for compliance with the *Motor Vehicle Act* diesel retrofit requirements, emission reduction devices are verified by the following agencies

- see Air Emission Legislation, page 10-6
- US Environmental Protection Agency
  [http://www.epa.gov/otaq/retrofit/verif-list.htm](http://www.epa.gov/otaq/retrofit/verif-list.htm)
- California Air Resource Board
  [http://www.arb.ca.gov/diesel/verdev/vt/cvt.htm](http://www.arb.ca.gov/diesel/verdev/vt/cvt.htm)

♦ use appropriately sized and efficiently operated heating plants for greenhouse and other production facilities
- use energy management systems that ensure optimization of temperature and humidity
- if used, ensure solid fuels have optimum moisture content (less than 20% moisture, suggested)
- implement rigorous maintenance programs for all heating system components, particularly for solid fuel boilers
- ensure that biomass fuelled boilers meet emission testing requirements
  - see Climate Change Mitigation Beneficial Management Practices, page 12-10, and refer to Energy Conservation and Fuel Switching

♦ change livestock feed rations to
- reduce nitrogen content of excretions thus reducing ammonia emissions
- reduce methane emissions

♦ use manure handling practices that minimize emissions
- make more frequent manure applications at lower application rates using sleighfoot or shallow injection equipment for more efficient use of nitrogen
- use covered manure storages to reduce methane and ammonia emissions
- use solid rather than liquid manure handling systems
  - see Manure Gas Emissions Reduction, page 3-33

♦ use drainage or irrigation systems to optimize soil water content
  - see Drainage Management Guide
  - see B.C. Irrigation Management Guide

♦ apply nutrients and manure efficiently to match crop needs
  - see Nutrient Management Reference Guide

♦ establish and maintain adequate windbreak or shelterbelt buffers around farm buildings and livestock facilities to improve energy efficiency
  - see Buffers, page 11-4

♦ increase carbon within the soil to reduce carbon entering the atmosphere
  - increase soil organic matter
  - minimize cultivation
  - grow perennial crops
  - avoid the burning of crop residue, and incorporate residues into soils

♦ follow beneficial management practices for open burning
  - see Open Burning Beneficial Management Practices, page 10-19
Ozone Production Reduction

Ozone is a secondary pollutant formed mainly from VOCs reacting with other contaminants in the atmosphere. Ground level ozone can have a negative impact on crop production. To reduce ozone production, reduce VOC production.

Ammonia Emissions Reduction

Agriculture is the largest emitter of ammonia to the air both in BC and globally. Ammonia easily volatilizes from urine, manure, fertilizer, compost and crop residues. It contributes to reduced visibility and reacts with other chemicals in the air to form secondary particulate matter, (i.e. ammonium sulphate and ammonium nitrate). These compounds are a major component of fine particulate matter in the air of the Fraser Valley. Elevated levels of fine particulate can reduce visibility and are a concern to human health.

- see Manure, page 3-33, and refer to Manure Gas Emission Reduction
- see Nutrient Application, page 6-28, and refer to Field Spreading Emission Reduction

VOC Emission Reduction from Fuel Evaporation

Fuel evaporation during storage results in VOC emissions and is an environmental concern. Evaporation from aboveground tanks is due to heating of the tank by the sun which causes the fuel to volatilize and vent to the atmosphere. Underground tanks have lower evaporation losses.

- see Petroleum Beneficial Management Practices, page 2-22 and refer to Petroleum Storage

Table 10.1 Agricultural Air Emission Sources

<table>
<thead>
<tr>
<th>Practice</th>
<th>Air Emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livestock and poultry housing (exhaust fans)</td>
<td>Ammonia, Dust and Particulates, GHG [CH₄], Odour</td>
</tr>
<tr>
<td>Poultry barn clean out</td>
<td>Dust, Particulates and Odour</td>
</tr>
<tr>
<td>Manure storage</td>
<td>Ammonia, Odour, GHG [CH₄],</td>
</tr>
<tr>
<td>Manure spreading</td>
<td>Ammonia, Dust and Particulates, Odour</td>
</tr>
<tr>
<td>Manure injection</td>
<td>GHG [N₂O] (in saturated conditions)</td>
</tr>
<tr>
<td>Open burning</td>
<td>Dust and Particulates, GHG [CO₂], Other Criteria Air Contaminants</td>
</tr>
<tr>
<td>Dry field tillage</td>
<td>Dust and Particulates</td>
</tr>
<tr>
<td>Diesel use</td>
<td>GHG [CO₂], Dust and Particulates, Other Criteria Air Contaminants</td>
</tr>
<tr>
<td>Fuel use</td>
<td>GHG [CO₂], NOₓ, SOₓ, VOCs, Particulates</td>
</tr>
<tr>
<td>Using boilers for heat production</td>
<td>GHG [CO₂], Dust and Particulates, Other Criteria Air Contaminants</td>
</tr>
<tr>
<td>Incinerators</td>
<td>GHG [CO₂], Dust and Particulates, Other Criteria Air Contaminants</td>
</tr>
<tr>
<td>Turning of compost windrows</td>
<td>Dust and Particulates</td>
</tr>
<tr>
<td>Grazing ruminants</td>
<td>GHG [CH₄]</td>
</tr>
</tbody>
</table>

GHG [specific gas] refers to Greenhouse Gas or Global Warming Gas
DUST AND PARTICULATE

DUST & PARTICULATE ENVIRONMENTAL CONCERNS

Primary environmental concerns related to dust and particulate are:

♦ release of mineral or organic compounds that contribute to particulate or secondary particulate formation that results in:
  • health risks when inhaling the particulate
  • visual impairment such as smog from the particulate in the outdoor (ambient) air

For information on these concerns:

⇒ see Air Quality Factors, page 10-1, and refer to Dust and Particulate

DUST & PARTICULATE LEGISLATION

The following is a brief outline of the main legislation that applies to dust and particulate.

⇒ see page A-1 for a summary of these and other Acts and Regulations

Local Bylaws

Regional and municipal governments can pass bylaws to control emissions such as backyard and open burning, wood stoves and vehicle idling. These governments can also address air pollution through land-use and transportation planning, regional growth strategies and sustainability plans. Permits may be given by local governments that restrict emissions from industry and business operations.

Environmental Management Act

This Act has a clause in section 3(5)(j) that gives an exemption for requiring a permit to introduce dust into the environment:

♦ “nothing in this section or regulation prohibits emission into the air of soil particles or grit in the course of agriculture or horticulture”

The Act is unclear on whether the release of “organic dust” from livestock barns through ventilation systems or from activities associated with grain cleaning and handling requires a discharge permit. However, regardless of permit requirements, pollution must not occur from any emission into the air.

The Code under the Agricultural Waste Control Regulation has two references to air emissions:

♦ Section 17: states that emissions from forced air ventilation systems must not cause pollution
♦ Section 18: regulates emissions from biomass fired boilers including particulate limits
Farm Practices Protection (Right to Farm) Act

This Act protects farmers from liability in lawsuits alleging nuisance associated with dust resulting from the farm operation when they meet certain regulatory conditions.

DUST & PARTICULATE BENEFICIAL MANAGEMENT PRACTICES

Suppression measures to prevent the release of dust from livestock barns and fields will contribute significantly towards reducing the potential for pollution and complaints. Comply with applicable dust related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

Dust Suppression

Dust can result from a variety of farm practices and can be a nuisance to neighbours. Several measures can be taken to reduce the amount of dust generated from farm activities. Implement the following practices for dust suppression:

♦ avoid cultivation in situations where the soil will become or is excessively dry
♦ minimize the amount of time soil is left bare in fields
♦ evaluate and modify activities that may create dust such as tillage, harvesting, grain handling, livestock handling, feed processing
  • work soils when moisture conditions are least likely to generate dust
  • practice minimum tillage
  • bale straw instead of chopping
♦ choose manure application methods that apply manure directly to the soil rather than into the air
♦ choose cropping, crop residue and cover crop management practices that minimize soil loss by wind erosion
  ➔ see Soil Erosion Risk, page 8-10
♦ design ventilation structures to deliver emissions either to the ground or to the air in a manner that reduces dust drift
♦ choose spray equipment which places spray on the target rather than into the air when there is a risk of drift
  ➔ see Pesticide Use, page 5-17

Particulate Suppression

Particulate matter 2.5 μm or smaller can remain suspended in the air. Implement the following practices for particulate suppression:

♦ avoid burning crop residue or land clearing
  ➔ see Open Burning, page 10-11
♦ maintain general sanitation and housekeeping in livestock housing
  ➔ see Indoor Poultry and Livestock Housing, page 3-
♦ reduce ammonia production that leads to secondary particulate formation
  ➔ see Manure Handling and Storage Beneficial Management Practices, page 3-35 and refer to Nutrition and Ration Management

Chapter 10 AIR 10-11
Dust and Particulate Capture

Some sources of particulates can be controlled using emission control devices to catch dust and particulates. This can be used for ventilated animal housing, boilers and internal combustion engines.

♦ keep internal combustion engines well maintained and include emission control devices if necessary (e.g. air filters, diesel injectors or catalytic converters)
♦ install a dust-removal system on building ventilation fans including chemical or wet scrubbers or cartridge filters
♦ install dust suppression system, such as an electrostatic precipitators, that will reduce airborne particulates and exhausted particles
♦ install bio-filters on animal housing to reduce dust and odours
♦ install vegetative filters to provide capture of dust at exhaust fan outlets
  ➔ see Indoor Poultry and Livestock Housing, page 3-3, and refer to Protection of Air Quality
♦ implement emission control devices on biomass burners
♦ use greenhouse boilers with low particulate generation
  • ensure solid fuels have optimum moisture content (< 20% moisture content, suggested)
  • implement a rigorous maintenance program for all heating system components, particularly for solid fuel boilers
  ➔ see Heat Production and Biomass Boilers, page 2-39
♦ develop wind screens, breaks or strategies to reduce dust movement off the property
ODOURS

ODOUR ENVIRONMENTAL CONCERNS

Primary environmental concerns related to farm odours are:

♦ direct odours and particulate carrying odorous compounds that come from animal housing areas, manure handling and storage areas and land where manure is applied, resulting in:
  • high levels of odours that result in air pollution and health impacts to humans
  • the nuisance they pose to neighbours

For information on these concerns:

➔ see Air Quality Factors, page 10-13, and refer to Odours

ODOUR LEGISLATION

The following is a brief outline of the main legislation that applies to odours.

➔ see page A-1 for a summary of these and other Acts and Regulations

Farm Practices Protection (Right to Farm) Act

This Act protects farmers from liability in lawsuits alleging nuisance associated with odour resulting from the farm operation when they meet certain regulatory conditions.

Environmental Management Act

This Act has requirements under the Code under the Agricultural Waste Control Regulation regarding odour:

♦ Sections 3 and 30: state agricultural wastes and products must be managed in a manner that prevents pollution

♦ Section 19: states “nothing in this Code is intended to prohibit various odours from agricultural operations or activities on a farm, providing such operations or activities are carried out in accordance with this Code”

A 1997 Provincial Court of BC judgement determined that odours that cause or are capable of causing material physical discomfort to a person are classified as an emission that causes pollution. Odours not causing pollution by this definition may still, however, be a nuisance.

ODOUR BENEFICIAL MANAGEMENT PRACTICES

Comply with applicable odour related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment and minimize nuisance to neighbours.
Odours from Livestock. Odours in livestock production typically originate from indoor livestock housing; from manure handling, storage and composting areas; and from fields during the course of manure spreading. Odours come from many sources, the most common are:

- ammonia from manure in indoor livestock housing
- odorous compounds carried on dust from indoor livestock housing, and from manure spreading
- odorous gases from manure storage, either wet or dry
- harmful odorous compounds from manure breakdown in the lack of oxygen (anaerobic conditions)

Odours associated with livestock operations are largely the result of gases produced from manure and other decomposing organic matter. Livestock housing can also produce odourous ammonia emissions from dry manure as well as dust that carries odour.

When manure decomposes in the presence of sufficient oxygen, a process known as aerobic decomposition, few malodorous gases are produced. On the other hand, the decomposition of manure in the absence of oxygen, known as anaerobic decomposition, results in the release of many odorous and often dangerous gases, including ammonia, hydrogen sulphide, methane, and other toxic organic chemical substances. Manure odours from solid manure can be minimized by keeping the manure sufficiently dry to allow air movement and aerobic conditions through the pile to occur.

➔ see Manure, page 3-33, and refer to Manure Gas Emission Reduction

Odours from Crop Residues. Decomposition of post-harvest crop residues or vegetative processing waste can result in significant odour generation if not managed properly. Specifically, residues from cole crops pose a high risk of odour generation that can be a nuisance to neighbours. In order to minimize odours from crop residues, incorporate residues into the soil immediately post-harvest. Dispose of waste from crop processing in a manner that minimizes odour generation.

➔ see On-farm Processing and Sales Beneficial Management Practices, page 2-42

Strategies to reduce odours can either be to prevent the gaseous emissions, cover gaseous emissions, or reduce particles carrying odour or prevent drift of particles carrying odour.

Farm Nuisance - Odour

Vegetative Buffers. Through the establishment of adequate buffers, odours can usually be managed to reduce nuisance or pollution. The use of vegetative buffers surrounding exhaust fans and farm boundaries, Figure 10.1, can effectively reduce the impact of odours.

- install vegetative buffers around exhaust fans or farm borders
- seek expert guidance when attempting to construct vegetative filters for odour or dust reduction purposes

➔ see Buffers, page 11-4
Implement the following practices to reduce odours from outdoor livestock areas:

♦ handle the manure as a solid and keep it as dry as possible
♦ minimize the area covered by manure in confined livestock areas
♦ clean pens often and move manure to storage facilities
♦ remove livestock mortalities promptly and dispose in an approved manner

Implement the following practices to reduce odours from barns:

♦ handle solid manure in as dry a state as possible
♦ remove wet manure from buildings frequently
♦ remove dead animals promptly and dispose in an approved manner
♦ install vegetative buffers surrounding barn exhaust fans
♦ use mechanical filters on barn exhaust to trap odorous dust particles
  ➔ see Indoor Poultry and Livestock Housing, page 3-4, and refer to Protection of Air Quality
♦ use chemical or biological odour control agents when other management methods are unsuccessful
  • several such agents are available commercially, but they have been used in the past with varying degrees of success
  • evaluate odour control products on-farm before buying large quantities

**Biofilters.** Biofilters are used in farm operations to trap and degrade odours within the air before they leave an indoor facility. Biofilters trap particulates that can carry odorous compounds and also reduce ammonia and hydrogen sulphide emissions by providing an environment for biological degradation of the trapped compounds.

♦ use biofilters or filters on barn exhaust systems
  ➔ see Indoor Poultry and Livestock Housing, page 3-4, and refer to Protection of Air Quality
Manure Storage and Handling

Long-term storage of manure is a necessity on many farms. Livestock and poultry producers farming on minimal land areas require storage to facilitate the timely sale or delivery of manure to crop producers. Carefully plan and manage the handling, composting, spreading or storage of all wastes to avoid the creation of odorous conditions. Comply with all manure storage regulations and implement the following beneficial management practices to avoid generation of odours:

♦ minimize disturbance of stored manure when putting fresh manure into storage tanks
♦ use covers on manure storage areas
♦ minimize surface area of manure to reduce emissions

→ see Manure, page 3-33, and refer to Manure Gas Emissions Reduction

Manure Treatment for Odours

In situations where well-managed manure storages or field spreading practices are not enough to control odours, manure treatment options can be considered. These could include aerobic treatment and carbon reduction for liquid manure systems and composting for solid manure. Where appropriate, implement the following manure treatment options:

♦ apply regular frequent aerobic treatments by mixing or turning manure to prevent anaerobic conditions
♦ apply additives to manure piles to reduce the impact of odours when land applying
♦ compost manure following the guidelines outlined in Chapter 2

→ see Compost, page 2-24, and refer to Compost Beneficial Management Practices

→ see Manure, page 3-33, and refer to Manure Gas Emissions Reduction
The term “open burning” is defined in the Open Burning Smoke Control Regulation as “the combustion of material with or without control of the combustion air and without a stack or chimney to vent the emitted products of combustion to the atmosphere.”

**OPEN BURNING ENVIRONMENTAL CONCERNS**

Primary environmental concerns related to open burning are:

- release of fine particles into the air that
  - results in a health risk from inhaling the particulate
  - results in visual impairment from the particulate
- escape of the open fire that results in a fire safety risk to the environment
- release of greenhouse gases, mainly carbon dioxide (CO₂) and release of other air contaminants that effect local air pollution
- release of other contaminants as a result of illegal burning of waste other then agricultural debris (e.g. plastics, coated woods and waste, solvents, wire, etc.)
  - results in health risks from inhaling the particulate and
  - results in health risks and environmental risks from deposition of contaminants in the localized environment

For information on these concerns:

⇒ see Air Quality Factors, page 10-1

**OPEN BURNING LEGISLATION**

The following is a brief outline of the main legislation that applies to open burning.

⇒ see page A-1 for a summary of these and other Acts and Regulations

Because burning is practiced in a wide range of farm activities, agriculture is given special consideration in legislation. Both municipal and provincial governments regulate open burning. Before carrying out any burning operation, check for:

- restrictions imposed by local government bylaws
- pollution concerns regulated by MOE under the Environmental Management Act
- fire safety concerns regulated by the Ministry of Forests, Mines and Lands under the Forests and Range Practices Act
Note: the following is only a summary of burning requirements, contact all relative agencies regarding necessary details before igniting any fire.

**Local Bylaws**

Local fire departments, municipalities, improvement districts or regional districts may have smoke management plans (guidelines), specific bylaws or restrictions on open burning. Where local regulatory requirements are more stringent, they apply over provincial legislation.

**Farm Practices Protection (Right to Farm) Act**

This Act protects farmers from liability in lawsuits alleging nuisance associated with odour, noise, dust or other disturbance resulting from the farm operation when they meet certain regulatory conditions.

**Environmental Management Act**

This Act provides the Ministry of Environment with the authority to manage, protect and enhance the environment.

There are specific standards and exemptions under the Open Burning Smoke Control Regulation and Code of Practice for various materials burned on the farm. A waste discharge approval or permit for burns is not required under this Act for:

- agricultural burning of leaves, crops, weeds, foliage or stubble
- residential (i.e., backyard) burning of leaves, foliage, weeds, crops or stubble
- burns that satisfy all the terms and conditions set out in the Open Burning Smoke Control Regulation and the Open Burning Smoke Control Code of Practice
- burns conducted to comply with the Weed Control Act

All other burns (e.g. household, industrial) require a waste discharge approval or permit from MOE. **Note: Metro Vancouver is the agency that gives approvals within its boundaries.** Even though permitted, open burning must not pollute the air. Schedule A provides a list of materials that are prohibited from being open burned.

The Open Burning Smoke Control Regulation requires a burn operator to:

- explore all possible options to reduce, reuse or recycle as much of the material as possible
- burn only vegetative matter such as tree branches, limbs, roots, shrubs, etc.
- burn only on the same site from which the material was gathered and not include material from offsite
- do not burn prohibited materials, or substances that normally emit dense smoke or noxious odours
- burn the material more than 100 m from a neighbouring residence or business and more than 500 m from a hospital, continuing care facility, or school that is in session
- ensure that smoke from open burning does not pose a hazard at airports or highways by significantly reducing visibility
- ensure that the ventilation index is "good" on the day the burn is started and forecast to be "good" or "fair" on the following day (see the regulation for further information and requirements)

ensure satisfactory control and feeding of the fire, and make sure adequate equipment and staff are available to ensure the regulatory limits are met

- follow all of the burning restrictions that are relevant to the sensitivity zone
  - these restrictions include a smoke release period of either 72 or 96 hours, and restrictions on the number and frequency of burns per year


**Wildfire Act** This Act regulates open fires within 1 km of forest land or grass land. It is administered by the Ministry of Forests, Mines and Lands.

- Section 2: requires reporting a forest land or grass land fire
- Section 3: prohibits dropping, releasing or mishandling a burning substance, or any other thing that the person reasonably ought to know is likely to cause a fire
- Section 4: states Section 5 & 6 do not apply to the City of Vancouver or a municipality or a local government having an open fire bylaw
- Section 5 & 6: regulates non-industrial and industrial open fires

**Wildfire Regulation.** This Regulation applies to all open fires within 1 km of forest land or grass land.

- Sections 4 – 12: outline fire prevention requirements
- Sections 13 – 17: outline fire control requirements
- Sections 18 – 24: outline permissible open fires (category 1, 2, 3 and resource management fires) - a burn registration number is required for category 3 fires – call toll free 1-888-797-1717
- Schedule 1: outlines three Danger Regions of BC
- Schedule 2: defines five different Fire Danger Classes using a matrix of Build-up Index and Fire Weather Index
- Schedule 3: provides restrictions on High Risk Activities as required in Section 6(3)

**OPEN BURNING BENEFICIAL MANAGEMENT PRACTICES**

Comply with applicable open burning related legislation, including the above, and where appropriate, consider the following beneficial management practices to protect the environment.

**Open Burning** The risks associated with outdoor fires are the reason for local and provincial regulations.

- whenever possible, consider alternatives to burning such as:
  - reducing the size of the materials (such as by chipping) to allow it to be used as mulch or used as a compost material
  - recycling as much material as possible before burning
- any fire attendee should have equipment and water on hand appropriate to control for the size and type of fire. Follow the information in the *Wildfire Act and Regulation*
- use the flow chart in Figure 10.2 to determine if the *Open Burning Smoke Control Regulation* applies to the open burn
Before you light a fire to burn debris, ensure you have REDUCED, REUSED and RECYCLED as much of the material as possible.

Are you planning on open burning? either from agricultural activities or on agricultural land?

- **Yes**
  - Are you planning on burning prohibited materials?
    - **Yes**
      - Is there a local Burn Ban in your area?
        - **Yes**
          - Are there any local, regional or other bylaws for open burning in your area?
            - **Yes**
              - Do you plan on open burning for pest or disease control?
                - **Yes**
                  - Do you plan on open burning debris from agricultural development?
                    - **Yes**
                      - Squaring up land
                      - Expanding cropping area
                      - Vegetation removal
                      - Cleaning up ditch lines
                      - Orchard or vineyard renovations
                    - **No**
                      - Are you planning on open burning only the following debris?
                        - **Yes**
                          - Leaves
                          - Crops
                          - Stubble
                          - "Foliage" - the vegetation removed in the maintenance of cropped plants
                        - **No**
                          - Exempt from the Open Burning Smoke Control Regulation
                            - Use Beneficial Management Practices
                      - **No**
                        - Follow Open Burning Smoke Control Regulation

- **No**
  - Do Not Burn

Follow the Burning Bylaw and if called for, the Open Burning Smoke Control Regulation

Follow Open Burning Smoke Control Regulation

Exempt from the Open Burning Smoke Control Regulation

Use Beneficial Management Practices

Prohibited Material
- Manure and / or animal bedding
- Plastics - including: twine, fertilizer bags, silage bags, plant pots, plastic sheeting
- Tires
- Treated lumber - including: posts, barn demolition material, treated wood plant pots, woody debris with metal attached
- Fuel, lubricant and fertilizer containers

Note: Before burning you must ensure that the venting condition forecast is appropriate for smoke dispersal, and appropriate set-back distances are met.

Figure 10.2 Burning Practices Flow Chart
Where agricultural burning is necessary, many smoke-related problems result from poor open burning practices. Emissions containing particulate matter from open burning can limit visibility, release harmful gases, and aggravate respiratory conditions in susceptible individuals. Particulate emissions and pollution can be reduced by implementing the following practices to reduce smoke production:

♦ build good piles with clean, dry debris (do not include stumps, rocks, or soil) to reduce smouldering stage
  • pile to approximate a haystack shape where the material does not splay out at the sides, and the dimensions approximate a base-to-height ratio of 1:1
  • avoid overloading of fires that may restrict combustion, and cause smouldering and increased smoke
♦ minimize the smouldering stage, as this stage can contribute more than half of the total particulate emitted during the burn
♦ control the fuel properties
  • avoid compaction of the material
  • allow fuel to dry before burning to reduce the moisture content of the pile
♦ use forced air technology (i.e. air curtain incinerators, or other appropriate air-assist technology) as these can reduce emissions by up to 90%
♦ avoid burning during periods of calm stable air or when the venting index is poor, when smoke is unlikely to disperse properly
♦ use woodwaste as heating fuel instead of open burning
♦ follow local smoke management plans guidelines on open burning within your municipality

Note: ensure that there are no contaminants in the fire, such as tires, plastic or other prohibited materials (see Table 10.2)

<table>
<thead>
<tr>
<th>Table 10.2</th>
<th>Materials Prohibited from being burnt under the Open Burning Smoke Control Regulation</th>
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</thead>
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<tr>
<td>tires</td>
<td>treated lumber</td>
</tr>
<tr>
<td>plastics</td>
<td>railway ties</td>
</tr>
<tr>
<td>drywall</td>
<td>manure</td>
</tr>
<tr>
<td>demolition waste</td>
<td>rubber</td>
</tr>
<tr>
<td>domestic waste</td>
<td>asphalt</td>
</tr>
<tr>
<td>paint</td>
<td>asphalt products</td>
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<tr>
<td>hazardous waste</td>
<td>fuel and lubricant containers</td>
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<tr>
<td>tar paper</td>
<td>biomedical waste</td>
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Although the Open Burning Smoke Control Regulation does not regulate the agricultural burning of crops, weeds, foliage or stubble, voluntary adoption of the Regulation is suggested for these burns.
### CHAPTER 11 METRIC CONVERSIONS

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<td>5 m</td>
<td>16.5 feet</td>
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<tr>
<td>7 m</td>
<td>23 feet</td>
</tr>
<tr>
<td>8 m</td>
<td>26 feet</td>
</tr>
<tr>
<td>30 m</td>
<td>100 feet</td>
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Conversions in this table are rounded to a convenient number. See Appendix E for exact conversion factor.

Values from tables and examples are not included in Metric Conversions.
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11 STEWARDSHIP AREAS

INTRODUCTION

This chapter discusses stewardship areas for protection of the environment. It contains introductory information on the relationship between these areas and the environment. It also contains information on environmental concerns, legislation and beneficial management practices related to:

♦ buffers
♦ riparian areas

STEWARDSHIP AND SUSTAINABILITY

Stewardship. This term is often used when dealing with issues surrounding the environment. Stewardship is loosely defined as “the individual’s responsibility to manage his life and property with proper regard to the rights of others”.

Stewardship is not only important to aquatic life and wildlife but to landowners as well. Healthy streams and riparian areas create a positive influence, for example, on the health of adjacent uplands, which are often productive farmland. Similarly, stewardship of native grasslands ensures continued biodiversity and resulting economic returns to the farm by creating long-term livestock forage availability. → see Stewardship crops, page 4-9

Watershed Stewardship: A Guide for Agriculture
Stewardship Options for Private Landowners in B.C.
Farms & Streams: The Farmers Guide to Stream Stewardship
Fringe Benefits: A Landowner’s Guide to the Value and Stewardship of Riparian Habitat

Sustainability. The root of this term is “sustain”, and could be defined as “management that meets the needs of the present without compromising the ability of future generations to meet their own needs”.

Sustainability is actions and considerations practiced by agricultural producers that utilize farm resources to ensure the success of the farm in a manner that considers the economic, environmental and social outcomes. When applied to natural resources, sustainability considers all parameters to ensure their long-term viability and success.
BUFFERS, RIPARIAN AREAS, AND THE ENVIRONMENT

Environmental concepts related to buffers and riparian areas are listed in alphabetical order below.

**Buffers**
Buffers on farms are generally defined as specially managed areas used to separate farm activities from sensitive areas that may be impacted by those activities. The objective of a buffer is to intercept and retain contaminants, preventing them from reaching a sensitive area or to deliver other agricultural or environmental benefits as described below. See Figure 11.1, next page.

Buffers can function as a barrier to reduce the risk of contamination or as an active or passive “treatment system” to remove contaminants before they reach sensitive areas. Most buffers are either a specially managed area of crops, a combination of crops and trees, or designed landscape plantings, and can include physical barriers such as fences, walls or berms. Buffers may be situated adjacent to farm buildings, manure storages, watercourses, or fields which receive manure or pesticides and are meant to protect watercourses, wells, roads, trails, and recreational or urban areas from adverse impacts. Buffers can provide a multitude of other benefits such as:

- reducing erosion and runoff
- enhancing aquatic and terrestrial habitat
- increasing soil productivity
- providing aesthetics and visual barriers
- reducing noise, odor and dust
- providing stable microclimates
- providing economic diversification

Many other terms are used in place of the word ‘buffer’ depending on their intended use. These include shelterbelt, windbreak, landscaped buffer, trap crop, catch strip, vegetative filter strip, hedgerow, conservation buffer, field margin, living snow fence, or riparian area.

**Riparian Areas**
Areas bordering watercourses or wetlands are known as riparian areas. Common to all riparian areas are the following:

- a combined presence and abundance of water, either on or close to the surface
- vegetation that responds, requires and survives well with abundant water
- soils that are modified by abundant water, stream or wetland processes and lush, productive and diverse vegetation.

The riparian areas along watercourses include the banks, a diverse array of plants and animals and the floodplain. A riparian area can be part of a buffer. See Figure 11.1, next page.

Riparian Management Field Workbook
Setbacks  A setback is a distance separating two things. It is not meant to be a treatment area like buffers. For instance, a setback may be required between a property line and a building.  ➔ see Farm Building Siting, page 2-4

Figure 11.1  Relationship between Buffers and Riparian Areas
**BUFFER ENVIRONMENTAL CONCERNS**

Primary environmental concerns related to ineffective or non-existent buffers are:

- contaminated runoff reaching a watercourse
- pesticide drift causing air, water, or soil pollution
- unreasonable odour, noise, or dust reaching neighbours
- uncontrolled temperature management resulting in inefficient heating or cooling of livestock, equipment and buildings
- soil erosion by wind or water
- weed, insect, or disease pest invasions
- unreasonable disturbances of wildlife at crucial times of the year

For detailed information on these concerns:

- see Impacts on Biodiversity and Habitat, page 7-8, and refer to Farm Activities and Impacts
- see Water Quality and Quantity Factors, page 9-2, refer to Contaminants
- see Air Quality Factors, page 10-1, refer to Contaminants, to Dust and Particulates, and to Odours

**BUFFER LEGISLATION**

The following is a brief outline of the main legislation that applies to buffer use.

- see page A-1 for a summary of these and other Acts and Regulations

**Local Bylaws**

Local governments may regulate aspects such as setbacks to control odour, noise and nuisance issues.

**Environmental Management Act**

The Code under the Agricultural Waste Control Regulation has requirements for agricultural wastes:

- Section 3: agricultural wastes, … must be collected, stored, handled, used and disposed in a manner that prevents pollution
- Section 30: agricultural products … must be managed to prevent the escape of agricultural wastes (agricultural products include farm inputs and outputs)

One way of meeting Sections 3 and 30 is to have effective buffers.

**Fish Protection Act**

The Fish Protection Act enables the protection of fish and fish habitats. Four main objectives of the Act are to ensure sufficient water for fish, enable fish habitat to be protected and restored, improve riparian habitat protection and enhancement, and to give local governments greater powers for environmental planning.
♦ Section 4: prohibits new dam construction on specified major rivers
♦ Section 6 and 7: allows designation of sensitive streams and recovery plans
  • such streams would have restrictions placed on new water licenses or approvals, or amendments to existing ones until the stream has recovered

**Riparian Areas Regulation.** This Regulation, under the *Fish Protection Act* establishes directives to protect riparian areas from development and to facilitate cooperation between DFO and the Union of BC Municipalities. It applies to the exercise of local government powers under the *Local Government Act*. The Regulation provides required riparian assessment methods by Qualified Environmental Professionals as a condition of approval for new residential, commercial, or industrial activities.

**Integrated Pest Management Act**

This Act and the *Integrated Pest Management Regulation* require pesticides to be used according to label directions, such as a specified buffer distance.

**Fisheries Act**

The three main sections of this Act regarding buffers are:
♦ Section 35(1): prohibits the harmful alteration, disruption or destruction of fish habitat unless authorized
♦ Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could enter through unhealthy riparian areas)
♦ Section 38(4): requires reporting infractions of Sections 35 or 36

One way of meeting items 35 and 36 is to have effective buffers.

**Pest Control Products Act**

Regulations under this Act require that users of pesticides follow the directions or limitations as shown on the pesticide label which may include the need for buffers.

**BUFFER BENEFICIAL MANAGEMENT PRACTICES**

Comply with the applicable buffer related legislation, including the above, and where appropriate, use the following beneficial management practices to protect the environment.

**Activities Requiring Use of Buffers**

Four specific farm activities may require the establishment of a buffer. Table 11.1, lists both the farm areas or activities and the type of buffers that can be used to protect sensitive areas.

<table>
<thead>
<tr>
<th>Table 11.1 Farm Activity and Buffer Type</th>
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<tr>
<td><strong>Farm Activity</strong></td>
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<td>Pesticide Application</td>
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<td>Bare or Cultivated Soil</td>
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Buffers are generally established for a multitude of outcomes and can provide extra insurance against unforeseen environmental problems, but should not be intended as the primary means of intercepting sediments and dissolved chemicals generated as a result of poor farming practices or the lack of a nutrient management plan.

Well-designed and maintained buffers have the capacity to:
♦ remove nutrients and pesticides (up to 50 percent)
♦ remove certain pathogens (up to 60 percent)
♦ remove sediment (up to 75 percent)
♦ reduce odour transmission (by up to 50 percent)
♦ reduce noise (by up to 50 percent)

**General Buffer Design**

Well-designed and maintained buffers have the capacity to:

- remove nutrients and pesticides (up to 50 percent)
- remove certain pathogens (up to 60 percent)
- remove sediment (up to 75 percent)
- reduce odour transmission (by up to 50 percent)
- reduce noise (by up to 50 percent)

**Buffer Width.** Since there are no generally accepted formulas to determine minimum buffer widths for specific functions, it is best to experiment with varying widths while monitoring effectiveness. Buffers may be a continuation of a forage field, a separately managed grass area, a planted belt of trees and shrubs, maintenance of a riparian area along a watercourse, or a combination of the above.

Required buffer widths and composition are a function of:
- the pollution or nuisance potential of a given farm activity
- the effectiveness of the vegetation to reduce pollution or nuisance
- the time of year an activity is occurring
- the sensitivity of an area to be protected
- the soil, topographic and climatic conditions associated with a site
- habitat values necessary to support biodiversity

Figure 11.2, next page, shows examples of suggested buffer widths based on an activity and its risk of impacting a sensitive area. While this example is for manure spreading equipment, the concept applies to other risk assessment situations as well. Application equipment which places manure accurately and directly on the soil surface will require a narrower buffer than, for example, equipment that distributes manure into the air. In addition, solid manure is less likely to move across a field than liquid manure during application or during subsequent rain events.

Buffer widths will vary with the type of activities and the time of year. Figure 11.3, page 11-8, shows an example of adjusting buffer width based on season. An early spring manure application will require a wider buffer than would a summer application. This is due to expected higher rainfalls, greater runoff flow events, and reduced grass nutrient uptake early in the growing season.

When the risk of contaminated runoff flow is high due to conditions such as high rainfall, reduced plant growth, or frozen soil, buffer width and filtering capacity will need to be increased. Vegetative filter strips function best on slopes of less than five percent and are ineffective on slopes greater than fifteen percent. Filter strips are less effective when plants are not actively growing and taking up nutrients.
Buffer Vegetation. Select plant species for buffers to:
- enhance beneficial insects
- be non-weedy or non-invasive ➔ see Weeds, page 5-9
- not be hosts for pests or diseases which could affect adjacent crops
- be able to be managed (e.g., by pruning, weed control)
- have a potential for economic return (e.g., harvest of forage or cuttings)

Monitoring Buffer Effectiveness. Ongoing monitoring is required to ensure that a buffer is accomplishing its intended objectives. Assess the effectiveness and integrity of buffers regularly to ensure that a contaminant or nuisance factor is not reaching sensitive areas. If a buffer is not providing adequate protection of a sensitive area, alter the buffer and/or the farm activity causing the impact.

Figure 11.2  Suggested Manure Application Buffer Widths Depending Upon Risk of Activity
Runoff Buffers

To establish an effective buffer, it is important to determine and implement the following buffer considerations. Note that buffer areas may need to be recontoured to prevent concentrated overland flow.

♦ choose buffer designs (vegetation types, layout and buffer widths) that match the site characteristics and sensitivity of a watercourse in order to:
  • catch and filter suspended solids such as manure or eroded soil
  • allow water carrying dissolved or soluble contaminants, such as nutrients and pesticides, to infiltrate the soil
  • minimize bank erosion

In combination with good agricultural practices, buffers are used to minimize the impacts of agricultural activities such as:

♦ movement of nutrients, sediment and pathogens to watercourses or wells
  • from intensive livestock operations
  • during and after soil amendment applications (e.g., manure)

♦ movement of pesticide residue to watercourses and wells after application

Windbreaks and Shelterbelts

Windbreaks and shelterbelts usually consist of multiple linear rows of various tree and shrub species. They are designed for environmental benefits such as protecting farmsteads and livestock areas, saving energy, enhancing wildlife habitat and for the production of marketable crops.

Windbreaks are specialized design structures such as snow fences or rows of vegetation consisting of trees planted in tight spacings to reduce wind speed, as shown in Figure 11.4, next page. They generally are planted at right angles to the prevailing winds to protect crops, soil, livestock and buildings.
A shelterbelt is usually designed with multiple linear rows of trees and shrub species and function much like a windbreak. They have multiple purposes such as providing wildlife habitat, improving the aesthetics of an area, or for harvesting of marketable products.

A windbreak or shelterbelt can provide several benefits such as:

- protecting buildings from excessive heat loss or gain
- protecting roads from wind and snow drift
- reducing soil erosion, soil moisture loss and crop stress
- altering the microenvironment for enhancing plant growth
- providing noise and visual screens
- improving air quality by reducing and intercepting dust, chemicals and odours
- improving irrigation efficiency
- improving habitat connectivity
- sequestering carbon

→ see Other Concepts Related to Climate Change, page 12-1

Tree or fence windbreaks may be used to protect buildings, roads, or fields. They have the ability to protect a distance of up to 30 times their height. Tall grass provides soil erosion protection; however, because grasses are more flexible, the protected area will only be 5 to 7 times their height. Figure 11.5, next page, illustrates the effect of windbreaks on reducing velocity. The optimum density of the windbreak for reduction in wind speed and interception of airborne particulates is 40% to 60%. Density of a planting is defined as the ratio of the solid portion of the planting to the total area planted.

Figure 11.4 Tree Windbreak
The advantages of windbreaks are especially important in dry years when low crop yields result in insufficient residue cover to protect the crop and soil from the drying effect of wind and temperature. Windbreaks also trap snow, increasing soil moisture for higher crop yields. This yield increase typically offsets yield losses associated with the need to take some land out of crop production for the windbreak planting.

- Field Shelterbelts for Soil Conservation
- Trees and Shrubs for Prairie Shelterbelts
- Wind and Snow Fences
- Farmstead Planning

http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1186590611493&lang=eng

Buffers for Pesticide Drift

Drift refers to the movement of droplets or vapours, by wind or air current, away from target areas. Drift may result from pesticide applications and a buffer area may be helpful in protecting sensitive areas in close proximity or downwind of an application. Buffers, as indicated on pesticide labels, are actually setbacks and are not active or passive treatment systems as described in this chapter. Pesticide buffers (setbacks) are generally intended for watercourses or for non-target terrestrial areas such as shelterbelts, hedges, woodlands, or wildlife habitat. To help reduce the impacts of spray drift it may be necessary to implement the following practices:

- maintain an untreated buffer between the treated area and downwind sensitive areas
- monitor wind direction during spraying to determine when sensitive areas are downwind of the sprayer
- follow pesticide labels, in particular check for buffers (setbacks) from watercourses, wells, sensitive vegetation and wildlife habitat
- use pesticide beneficial management practices
  - see Pesticides, page 5-11

Note that if vegetation is planted to intercept pesticide drift, then pesticide buffers (setbacks) indicated on the label for sensitive terrestrial areas may have to be followed for the newly planted vegetation.
Buffers for Mist and Dust

Specifications for mist or dust buffers are generally a recommendation of setback distances and species of planting similar to those in windbreaks and shelterbelts. The buffer must be designed to reduce wind velocity in order to allow the particulate matter from agricultural activities to settle out or be trapped on foliar structures like conifer needles. Examples of such activities include fertigation, manure application, dust from field or yard activities, or livestock building ventilation.

Mist Control. Mist refers to the small droplets or vapours generated by farm activities such as manure or pesticide application. (see Buffers for Pesticide Drift above). Mist drift can be reduced by using buffers to trap droplets. To minimize the amount of airborne mist, implement the following practices:

- use plant density of 40% to 60% to trap mist (the best species for this purpose are conifer tree species such as long needle pines)
- select plants with dense branching and twig structure
- use long lived species requiring low maintenance
- use multiple deciduous species with small leaves, hairy or coarse surfaces

Dust Control. Dust refers to particulate matter or soil carried by wind or air current. Dust can be a substantial irritant or safety concern to workers, neighbours and livestock. To minimize the amount of airborne dust, implement the following practices:

- ground-level foliage such as grass or shrubs should be planted and maintained to trap dust that exits the barn through exhaust fans
- remove dust accumulations from the buffer to ensure that foliage growth remains vigorous and effective
- establish vegetative buffers such as shrubs and trees along field margins or roads that generate dust during vehicle movement or field activity
- use plant density of 40% to 60% to trap dust (the best species for this purpose are conifer tree species such as long needle pines)
- select plants with dense branching and twig structure
- use long lived species requiring low maintenance
- use multiple deciduous species with small leaves, hairy or coarse surfaces

Buffers for Odour and Noise

Odour Reduction. An odour buffer is characterized by a tightly spaced tree and shrub planting usually planted in close proximity to a livestock facility and perpendicular to the prevailing winds. Most odours generated by livestock facilities travel as particulates suggesting that buffers or shelterbelts can reduce livestock odours by impeding the movements of these particulates. The function of buffers is that the vegetation creates air turbulence causing the odour to either be diluted or trapped within the foliage. For an effective buffer, implement the following practices:

- establish effective, vegetative buffers between agricultural operations and neighbours
- choose tree and shrub species that effectively screen out particulates and provide an effective visual screen
- consider prevailing winds, screens and terrain when designing odour buffers
- monitor odour levels in sensitive areas

see General Buffer Design, page 11-6

Landscaped Buffer Specifications
Noise Control. A noise buffer can be a structural barrier such as a noise absorbent or deflective wall, a berm, or a dense vegetative planting consisting of trees and shrubs. Livestock and the operation of equipment can generate significant amounts of noise. Note that vegetation will not stop some sounds such as bird scaring cannons which may need to be deflected by a wall or berm. To reduce noise impacts on humans and sensitive areas, implement the following practices:

♦ evaluate the nuisance level of noise created by a specific farm activity
♦ establish a sufficiently large setback from neighbours for structures containing stationary power equipment or livestock
♦ construct a noise barrier or establish an effective vegetative buffer zone by planting a shelterbelt of broadleaf and coniferous trees and shrubs
♦ monitor noise levels in sensitive areas
♦ use the standards established by the Farm Industry Review Board for audible bird scare devices

Wildlife Damage Control – South Coastal BC
Wildlife Damage Control – Interior BC
see General Buffer Design, page 11-6

Buffers for Biodiversity
Shelterbelts and buffers can provide benefits to wildlife in several ways, including protection from wind and adverse weather, escape or refuge cover, food and foraging sites, reproductive habitat and travel corridors. Shelterbelts designed for the purpose of wildlife enhancement should be of sufficient size to provide winter food and weather protection appropriate for local climatic conditions. The following buffer practices will help support wildlife:

♦ an increase in the density and diversity of native plant species
♦ establish buffers to minimize auditory and visual intrusion
  • length and width will depend on wildlife species and critical life cycle period
♦ maintain buffers to provide connectivity across a landscape
  • connectivity is necessary during some critical life cycle periods
RIPARIAN AREAS

RIPARIAN AREA CONCERNS

Primary environmental concerns related to riparian area protection are:

♦ farm buildings located within riparian setback distances resulting in impacts to vegetation and water quality
♦ equipment operation in riparian areas resulting in impacts to vegetation, bank stability and water quality
♦ livestock access to riparian areas resulting in impacts to vegetation, bank stability and water quality
♦ intensive crop production in riparian areas resulting in impacts to vegetation, bank stability and water quality
♦ land clearing and development that results in impacts to vegetation, bank stability and water quality

For information on these concerns:
⇒ see Pest Management, page 5-1
⇒ see Impacts on Biodiversity and Habitat, page 7-8, and refer to Farm Activities and Impacts

RIPARIAN AREA LEGISLATION

The following is an outline of the main legislation that applies to riparian area protection.
⇒ see page A-1 for a summary of these and other Acts and Regulations

Fish Protection Act

The Fish Protection Act enables the protection of fish and fish habitats. The four main objectives of the Act are to ensure sufficient water for fish, enable fish habitat to be protected and restored, improve riparian habitat protection and enhancement, and give local governments greater powers for environmental planning.
♦ Section 4: prohibits construction of new dams on specified major rivers
♦ Section 6 and 7: allows designation of sensitive streams and recovery plans
  • such streams would have restrictions placed on new water licenses or approvals, or amendments to existing ones until the stream has recovered

Riparian Areas Regulation. This Regulation, under the Fish Protection Act establishes directives to protect riparian areas from development and to facilitate cooperation between DFO and the Union of BC Municipalities. It applies to the exercise of local government powers under the Local Government Act. The Regulation provides required riparian assessment methods by Qualified Environmental Professionals as a condition of approval for new residential, commercial, or industrial activities.
**Wildlife Act**  
The provincial *Wildlife Act* protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

**Fisheries Act**  
The three main sections of this Act regarding riparian areas are:

- Section 35(1): prohibits the harmful alteration, disruption or destruction of fish habitat unless authorized
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substance could enter through unhealthy riparian areas)
- Section 37: requires approval for any work that may impact fish habitat
- Section 38(4): requires reporting infractions of Sections 35 or 36

**Species at Risk Act**  
The purpose of this Act (SARA) is to prevent native species in Canada from becoming extirpated or extinct, to provide for the recovery of endangered or threatened species and to manage species of special concern to prevent them from becoming endangered or threatened. Once a species is legally listed, the Act requires that recovery strategies be developed for extirpated, endangered and threatened species, and that action plans be developed where recovery is feasible.

- Schedule 1 of the Act sets out the legal list of species at risk (extirpated, endangered, threatened and special concern) in Canada.

Where the Act applies, it makes it illegal to kill, harm, harass, capture or take a species at risk, or to possess, collect, buy, sell or trade any individual or parts of an individual that is at risk. The Act also prohibits the damage or destruction of either the residence (for example, the nest or den) or the critical habitat of any species at risk. Critical habitat is legally identified in a posted recovery strategy or action plan.

While the Act applies to all land and waters in Canada, these prohibitions only apply to areas of federal jurisdiction including migratory birds, all waters (sea and fresh) in Canada, as well as to all federal lands, including Indian reserves and national parks, and the airspace above them.

- **On private land,** the SARA prohibitions apply only to:
  - aquatic species at risk; and
  - migratory birds listed in the *Migratory Birds Convention Act, 1994* and also listed as endangered, threatened or extirpated in Schedule 1 of the Act

The provisions of the Species at Risk Act (known as the ‘safety net’) could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

Note that SARA prohibitions do not apply to species of special concern, and that species at risk in Canada may also be protected by provincial or territorial laws. More information about how the Act applies on private land can be found on the Species at Risk Act public registry at:

[http://www.sararegistry.gc.ca/involved/you/privland_e.cfm](http://www.sararegistry.gc.ca/involved/you/privland_e.cfm)
The Regulation under this Act has sections of importance:

♦ Section 6: no person shall: disturb, destroy or take a nest, egg, nest shelter, eider duck shelter or duck box of a migratory bird without permit

♦ Section 24(1): any person may, without a permit, use equipment, other than an aircraft or firearms, to scare migratory birds that are causing, or a likely to cause damage to crops or other property (other control measures require a permit)

♦ Section 33: no person shall introduce into Canada for the purpose of sport, acclimatization or release from captivity a species of migratory bird not indigenous to Canada except with the consent in writing of the Director.

♦ Section 35(1): prohibits the deposit of oil, oil wastes or any other substance harmful to migratory birds in any area frequented by migratory birds

Comply with the applicable riparian area related legislation, including the above, and where appropriate, use the following beneficial management practices to protect the environment.

**Riparian Areas**

The areas bordering watercourses and wetlands, known as riparian areas, usually have vegetation that is different and more productive than the surrounding upland area due to the presence of water. Stream or wetland health is closely related to the vigor and composition of the border vegetation, which in turn, is an important factor in the condition of the water table and surrounding land. The health of a stream is an indicator of the conditions of the surrounding watershed; a stream, in effect, is an “end product barometer” of a watershed.

In the Interior of BC, riparian areas are easily identified as the green vegetation that is in stark contrast to the brown and yellow vegetation of the drier uplands. In coastal areas of BC, riparian areas may not always have this vegetation contrast. Some of the most endangered plant communities in the province occur in riparian areas, especially in very dry regions. In these dry areas riparian areas are particularly important to the health of watercourses and the fish and other aquatic life that depend on them. Healthy riparian areas are critical to protecting stream banks and adjacent farmland from erosion.

- **Biodiversity and Riparian Areas - Life in the Green Zone**
- **Caring For the Green Zone: Riparian Areas and Grazing Management**
- **Protecting Your Shorelands for Better Farming and Ranching, and Healthier Fish Habitat**
- **Riparian Areas - A Users Guide to Health**
- **Riparian Health Assessment for Streams and Small Rivers - Field Workbook**
- **Watershed Stewardship: A Guide for Agriculture**

**Riparian Functions.** A healthy riparian area will demonstrate some of the following key ecological functions:

- builds and maintains stream banks
  - stores floodwater and reduces stream flow energy
  - recharges groundwater
  - traps sediments
  - filters nutrients from water
  - maintains and enhances biodiversity
- shades the stream to reduce solar heat gain
♦ provides overhead cover and protection from raptors
♦ provides important nesting, cover and feeding habitat for breeding and migratory birds and other wildlife
♦ supports insect life for fish
♦ provides large woody debris from riparian areas which
  • provides shelter and resting places for fish
  • adds diversity to the in-stream habitat by allowing the formation of pools and spawning areas
  • reduces stream flow velocity
♦ sequesters carbon

→ see Other Concepts Related to Climate Change, page 12-1

Table 11.2  Basic Riparian Assessment Questions ★

1. Are the banks of the watercourse free of damage that results in exposed soil or bank slumping?
   • Exposed soil or bank slumping can be caused by concentrated overland flow, recreational use, farm equipment or hoof action of livestock. Riparian areas with any exposed soil or bank slumping should be assessed in more detail.

2. Are all areas of the banks of the watercourse covered with some type of vegetation?
   • Vegetation protects soil from the impact of storm events that could carry soil from stream banks into the watercourse. Any riparian areas missing some vegetation should be assessed in more detail.

3. Are shrubs and trees present on all watercourse banks? (not applicable if trees or shrubs are not native in that location or if the watercourse is a constructed ditch)
   • Shrubs and trees have deeper roots than grass and other herbaceous plants providing a root mass that is more resilient to the impact of flood events and stream scour on stream banks. Any riparian areas that have less than 15% total canopy cover of trees and shrubs (where they should occur naturally) should be assessed in more detail.

4. Do shrubs along or near the watercourse edge grow without a mushroom or hedged appearance?
   • Mushroom or hedge shaped riparian shrubs are an indication of over grazing. Riparian areas with shrubs in this condition should be assessed in more detail.

★ Producers with riparian areas lacking these features should refer to the Riparian Management Field Workbook publication for detailed assessment and management ideas to improve riparian conditions.
Riparian Functioning Condition. To evaluate the health of a riparian area, the functioning condition of the area is assessed. Functioning condition is a term that refers to the interactions between the soil, water, geography and vegetation of a site. There are three levels of functionality as shown in Figure 11.6.

- **Healthy or proper functioning condition:** healthy riparian areas with the most stable, non-eroding lands, the best fish and wildlife habitat and the best agricultural productivity
- **Healthy but with problems or functional but at risk:** areas that are lacking in some healthy features, and may be experiencing some stream bank erosion, lowering of the water table and fish and/or wildlife habitat may be at risk
- **Un-healthy or non-functional:** areas that have few if any healthy features, likely to have eroding banks, deepening channels and subsequent lowering of the water table over time, poor fish habitat and poor agricultural productivity

Negative impacts on, or loss of, riparian health may also affect the surrounding uplands. Proper functioning condition of riparian areas is the result of good management and benefits all the users within the area, including the landowner.

Some of the key components to management of riparian areas are directly linked to maintaining good soil and water conservation practices across the landscape and preserving, as much as possible, the integrity of the natural riparian zone. Specific land management practices that protect riparian areas include:

- maintaining a vegetative cover over the soil throughout the year
- minimizing animal trampling or vehicle traffic on wet soils
- avoiding overuse of fertilizers or manure that may be transported into riparian areas
- avoiding applying or disposing of toxic substances on soils
- protecting against loss of toxic substances on soils
- protecting against the establishment of exotic or non-water-loving species in riparian areas
- avoiding practices that artificially alter streamflow

Riparian Area Management

In some cases, the condition of the riparian area has diminished to the point that it may require some investment to bring the area up to a healthier or proper functioning condition. Improvement of agricultural riparian areas can occur by implementing the following practices:

- plant new vegetation
- control invasive weeds
- encourage a diverse mix of plant species and age that
  - are adapted to the climate, soil and water conditions
  - fosters a good rooting system for bank stability
- protect vegetation from livestock overgrazing or trampling through a grazing management plan by
  - considering grazing duration and density in relation to plant growth
  - considering stream bank soil moisture content
  - consider improving water supply for livestock by providing an off-stream water system or a restricted watercourse access
- protect vegetation from harmful pesticide or nutrient management applications
♦ improve stability with erosion control structures by:
  ♦ contouring terraces with earthworks and seeding
  ♦ stabilizing gullies and waterways with erosion control matting, silt fencing, seeding
  ♦ stabilizing banks through bank shaping, revetment, gabions, riprap, crib walls, re-vegetation, and blanketing
  ♦ utilizing drop inlet and in-channel control structures
  ♦ improving infiltration of concentrated water flow with filter trenches, filter wells, diffusing wells, etc.
  ♦ installing or upgrading retention ponds and erosion control dams

Healthy or Proper Functioning Condition

♦ healthy riparian areas with the most stable, non-eroding lands, the best fish habitat and the best agricultural productivity. Other attributes are the ability to: reduce stream energy therefore reducing erosion and improving water quality; filter sediment; capture bedload and aid in floodplain development; improve water retention and groundwater recharge; develop root masses to stabilize banks; develop ponding and channel characteristics to provide fish habitat; support greater biodiversity. This riparian area would probably score as “healthy”

Healthy But With Problems or Functional But At Risk

♦ areas in a healthy but with problems condition that are lacking in some healthy features indicating that some of their water, soil and vegetation characteristics are at risk thus leading to some potential stream bank erosion, lowering of the water table or putting fish habitat at risk. This riparian area would probably score as “healthy but with problems”

Non-Functional

♦ areas that have few if any healthy features, likely to have eroding banks, deepening channels and subsequent lowering of the water table over time, poor fish habitat and poor agricultural productivity. This riparian area would probably score as “unhealthy”.

Figure 11.6 Examples of Functioning Conditions of Riparian Areas
Integrated Riparian Management. Agricultural use of riparian areas can occur when the function of the riparian area is maintained. Implement the following practices:

♦ if livestock are well managed, forages grown in riparian areas can be harvested by grazing such as in riparian pastures
  ➤ see Outdoor Livestock Areas, page 3-7, and
  ➤ see Watering Livestock Directly from Watercourses, page 9-13

♦ traditional crops that are planted, managed and harvested appropriately can be grown in riparian areas, such as hay
  ➤ see Nutrient Application, page 6-8
  ➤ see Chapter 5, Pest Management

♦ specialty crops that can be harvested by hand can be grown in riparian areas and can include:
  • floral crops (pussy willow, contorted willow, ferns)
  • medicinal crops (cascara bark, hawthorn leaves and fruit)
  • food crops (fiddleheads, berries, nuts) and conifer boughs for the Christmas market
### CHAPTER 12 METRIC CONVERSIONS

<table>
<thead>
<tr>
<th>Metric</th>
<th>Imperial Equivalent</th>
</tr>
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<tbody>
<tr>
<td>5 °C</td>
<td>41 °F</td>
</tr>
<tr>
<td>7 °C</td>
<td>45 °F</td>
</tr>
<tr>
<td>0.1 m</td>
<td>.33 feet</td>
</tr>
<tr>
<td>1 m</td>
<td>3.3 feet</td>
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</tbody>
</table>

Conversions in this table are rounded to a convenient number. See Appendix E for exact conversion factor.

Values from tables and examples are not included in Metric Conversions.
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INTRODUCTION

This chapter discusses farm management practices for the reduction of greenhouse gas emissions that are produced by agriculture. It contains information on how climate change will impact agriculture, as well as adaptation methods that farms can implement to reduce the production risks associated with climate change. It also contains information on environmental concerns, legislation and beneficial management practices related to:

♦ climate change mitigation  ♦ climate change adaptation

This chapter is not intended to provide extensive solutions but to raise awareness and to encourage consideration of the relationship between climate change and agriculture. For information on specific concerns about climate change and local agriculture refer to AGRI, MOE or other resource people as well as the resources listed in this chapter.

CLIMATE CHANGE FACTORS

Agricultural Greenhouse Gases (GHGs)

Note: Also known as Global Warming Gases

Greenhouse Gases (GHGs). When the sun’s rays strike the earth, light energy is converted into heat energy which is radiated into the atmosphere. Certain gases block the escape of this heat energy, resulting in a warming of the Earth’s atmosphere known as the ‘greenhouse effect’. Carbon dioxide, methane, nitrous oxide and other gases that contribute to the greenhouse effect are discharged by many natural and human activities, including agriculture.

Carbon Dioxide (CO₂). Carbon dioxide is a greenhouse gas produced by the combustion of fossil fuels and biomass and from deforestation or clearing of agricultural land. It is a major contributor to the greenhouse effect and is therefore associated with climate change.

Methane (CH₄). Methane is a greenhouse gas produced during anaerobic decomposition (decomposition in the absence of oxygen) of organic wastes such as manures. Animals, particularly ruminants, emit methane gas during digestion which contributes to the greenhouse effect.
Nitrous Oxide (N\textsubscript{2}O). Nitrous oxide is a greenhouse gas produced in the soil from the biochemical reduction of nitrate to gaseous nitrogen compounds, a process known as denitrification.

Adaption. Adjustment of agri-food practices to maintain competitive production advantages during comparatively rapid changes in the regional climate.

Carbon Offsets. Carbon offsets are a result of a project or action that reduces the amount of greenhouse gas emissions entering the atmosphere, prevents GHG emissions from entering the atmosphere, or increases the amount of GHGs being taken out of the atmosphere and sequestered for a specified period of time.

A carbon offset system is a financial instrument that establishes tradable credits for GHG reductions and is aimed at encouraging cost-effective reductions or removals of GHGs. One carbon offset represents the reduction of one metric ton of carbon dioxide or its equivalent in other GHGs.

Carbon Sequestration. Plants and soil organic matter play an important role in removing carbon dioxide from the air and storing (sequestering) it. Carbon is the main component in plant material and soil organic matter. Any uptake of carbon dioxide from the air by plant material or soil reduces the effects of climate change.

Global Warming Potential (GWP). Each GHG differs in its ability to block the escape of heat energy. The combination of the GHG’s structural ability to trap heat and its viable time as a discrete molecule in the atmosphere determines the GWP of each greenhouse gas. GWP is a relative unit measured against the baseline of carbon dioxide (CO\textsubscript{2}). For example, methane has a GWP of 21 (i.e. 21 times the warming effect of CO\textsubscript{2} over 100 years). Carbon dioxide equivalency (CO\textsubscript{2}e) is based on the Global Warming Potential (GWP) over a 100 year time span. One tonne of CH\textsubscript{4} is worth 25 tonnes of CO\textsubscript{2}e and one tonne of N\textsubscript{2}O is worth 298 CO\textsubscript{2}e.

Fossil Fuel. Products such as fuel oil, gasoline, diesel, propane and natural gas are fossil by nature. They are produced from carbon chains that have been stored underground for millions of years. When these fuels are extracted and burned they release CO\textsubscript{2} to the atmosphere. The current rate of fossil fuel combustion is much higher than the rate of carbon sequestration leading to a net increase in the atmospheric CO\textsubscript{2} concentration.

GHG Reduction. Reduction projects are those that reduce or prevent the release of GHGs into the atmosphere.

Mitigation. Projects, actions and management practices that result in a reduction of greenhouse gas emissions from farms and agri-food activities.
CLIMATE CHANGE AND AGRICULTURE

What is Climate Change

Climate change refers to changes in the modern climate as a result of human activities that have increased GHG concentrations in the atmosphere. The vast majority of the scientific community agrees that climate change is caused by greenhouse gases (GHGs) in the atmosphere that trap heat by reflecting it back to the Earth, resulting in warming.

Figure 12.1 A simplified representation of the greenhouse effect
Many activities from farm operations release GHGs into the atmosphere. The main GHGs produced by agriculture include:

- Carbon Dioxide (CO₂)
- Methane (CH₄)
- Nitrous Oxide (N₂O)

These gases also exist naturally and are constantly exchanged between the atmosphere, the oceans, the soil, and living organisms. A net increase in the atmospheric concentrations of these gases is occurring due to human activities, including agriculture.

Figure 12.2. Example of an agricultural carbon cycle
Climate Change Impacts

Some impacts of broad temperature and precipitation shifts may take time to emerge, while others such as the increase in frequency of extreme weather events may be observed more immediately. In general, BC is expected to experience warmer, wetter winters and hotter, drier summers. Although warmer temperatures may seem appealing, climate change can have significant social, economic and environmental consequences. Some of the anticipated impacts include:

- a 2 to 7 degree Celsius increase in average annual temperature in BC by 2080
- glacial retreat and decreased snowfall in alpine areas leading to reduced snowpack and water shortages due to reduced stream flow
melting of the permafrost
- increased storm surges in some areas and subsequent vulnerability to flooding and erosion
- sea level rise of 0.1 – 1.0 m
- more frequent and intense extreme weather events and disasters such as wind-storms, forest fires, snowstorms, hail, droughts, and floods
- changes in ecosystems and ecosystem functions resulting in changes in biodiversity and habitats
- greater potential impacts to species at risk and fisheries
- new pest and disease outbreaks

http://www.env.gov.bc.ca/cas/impacts/bc.html

IMPACTS OF AGRICULTURAL ACTIVITIES ON GREENHOUSE GAS EMISSIONS

Agriculture’s Contribution to Climate Change

Overall, BC’s agriculture industry is a relatively small contributor to the total GHG emissions in the province. Estimating the magnitude of the emissions associated with agriculture is complex because of the range of agricultural practices and other variables such as soil, climate and land cover. The most recent BC Greenhouse Gas Inventory Report 2007 estimates that agriculture was directly responsible for about 3.5% of BC’s total GHG emissions in 2007. The sources of agricultural emissions identified in the report include:
- enteric fermentation
- manure management
- soil management practices

The report attributes 49.0% of BC’s total GHG emissions produced by agriculture to enteric fermentation, 35.3% from agricultural soils and 15.7% from manure management.

The agricultural sector total does not include emissions related to deforestation on agricultural or range land or on-farm energy consumption from electrical or fossil fuel driven equipment. Emissions from these sources are all included in other sections of the GHG Inventory.

Farm Activities and Impacts

Gas exchanges occur naturally between the atmosphere, oceans, soil and living organisms. Agricultural practices that disturb natural ecosystem functions can accelerate or amplify the release of GHGs into the atmosphere.

Other components of the food system contribute to GHG emissions. Examples of GHG sources include:
- emissions from energy needed for food processing
- transportation and storage associated with food products
- chemical fertilizer production

Sources of GHGs attributed to off-farm aspects of the food system will not be discussed in this chapter, as they are largely out of control of individual farmers.
The following are on farm activities that are known to impact climate change. Activities are listed in alphabetical order.

**Clearing Land.** Clearing land for crop production, releases CO₂ that was previously bound in soil organic matter and biomass such as trees and grasslands. This contributes to a net increase in atmospheric CO₂ concentrations.

**Combustion of Fossil Fuels.** The combustion of fossil fuels such as oil, diesel, propane, gasoline and natural gas for heat production, transportation and the powering of farm equipment contribute to net increase in atmospheric CO₂ concentrations.

**Enteric Fermentation.** Enteric fermentation is a process that takes place in ruminant livestock which converts carbon in feed to CH₄. This process contributes to a net increase in atmospheric CH₄ concentrations.

**Manure.** Anaerobic digestion (decomposition in the absence of oxygen) during storage of livestock manure emits CH₄, contributing to a net increase in atmospheric CH₄ concentrations. Manure also undergoes nitrification and dinitrification, producing N₂O emission during decomposition.

**Mineral and Organic Fertilizer Use.** When fertilizers are used in agricultural production, some nitrogen may be converted from forms that do not impact GHG emissions to N₂O, contributing to a net increase in atmospheric N₂O concentrations.

**Soil Organic Matter Degradation.** Soil organic matter degradation is accelerated by various farm practices such as tillage. This contributes to a net increase in atmospheric CO₂ concentrations as less carbon is sequestered in the soil.
Environmental concerns related to climate change mitigation and GHG emissions from agriculture are:

- enteric fermentation from cattle that results in CH$_4$ emissions
- manure production and storage that results in CH$_4$ emissions
- mineral and organic fertilizer use that results in N$_2$O emissions
- burning of fossil fuels that results in CO$_2$ emissions
- clearing land for crop production that results in CO$_2$ emissions from carbon that was previously sequestered
- soil organic matter degradation, which is accelerated by farm activities, that results in CO$_2$ emissions and reduced sequestration

For more information on these concerns:

- see Impacts of Agricultural Activities on Greenhouse Gas Emissions, page 12-6

The following is a brief outline of the main legislation that applies to climate change mitigation.

- see page A-1 for a summary of these and other Acts and Regulations

**Carbon Tax Act**

The Carbon Tax Act establishes a carbon tax in BC. The carbon tax is a broad based tax that applies to the purchase or use of fuels, such as gasoline, diesel, natural gas, heating oil, propane, coal, and the use of combustibles, such as peat and tires, when used to produce heat or energy. Carbon tax applies to fuels at different rates depending on their anticipated carbon emissions, and the tax rates are scheduled to change on July 1, 2011 and 2012. Farmers are required to pay carbon tax on fuel purchased or used for farming operations.

**Environmental Management Act**

The Code under the Agricultural Waste Control Regulation regulates emissions from agricultural practices. Applicable sections include:

- Section 18: regulates the type of fuel and emissions from wood fired boilers used in agricultural production.
- Sections 18.1 – 18.6 set emission standards, testing and reporting requirements for boilers and heaters fuelled by biomass.
The *Waste Discharge Regulation* authorizes the introduction of waste into the environment from certain industries, businesses and operations. Proponents of an on-farm anaerobic digestion project will require a waste discharge authorization. Guidelines for on-farm anaerobic digestion are available from the Ministry of Environment.

**On-Farm Anaerobic Digestion Waste Discharge Authorization Guideline**

www.bcfarmbiogas.com

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**Greenhouse Gas Reduction (Cap and Trade) Act**

The Act provides the legislative authority to implement a cap-and-trade system for GHGs which includes the establishment of reporting and compliance requirements. It also provides authority for regulations to establish criteria for projects that qualify as GHG offsets in a regulated offset system.

Single sites which emit 10,000 tonnes or more of CO₂ per year have to report their emissions, and those which emit 25,000 tonnes or greater will be regulated. There is currently only one agricultural facility in BC which emits over 25,000 tonnes per year and a few that emit more than 10,000 tonnes which are required to report their emissions.

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**Greenhouse Gas Reduction Targets Act**

The Act commits British Columbia to reductions of GHG emissions (of 2007 levels) by at least 33% by 2020. By 2050 it commits British Columbia to reductions (of 2007 levels) by at least 80%. Although emissions reductions for agriculture are not regulated, if agricultural emissions are not reduced while the rest of society does, the perceived impact of agriculture’s contribution to climate change will increase.

Under the Act, public sector organizations are required to be carbon neutral by 2010. Through the Climate Action Charter (separate from the Act), a large number of Local Governments have agreed to become carbon neutral and can develop municipal Climate Plans to mitigate emissions. Through this process Local Governments may encourage reduction of agricultural GHG emissions in the municipality.

The *Emission Offsets Regulation* sets out the requirements for greenhouse gas reductions and removals from projects or actions that qualify as emission offsets for the purpose of fulfilling the provincial government’s commitments to be carbon neutral by 2010.

---

**Zero Net Deforestation Act**

The *Zero Net Deforestation Act* was enacted in 2010 and commits British Columbia to achieving no net deforestation in the province by 2015. Deforestation, under the Act, is defined as “the permanent loss of the human-induced removal of trees from an area of forest land to such an extent that the area is no longer forest land.” The Act aims to mitigate greenhouse gas emissions associated with deforestation.
Greenhouse gas emissions from agricultural activities can be reduced through more efficient management of the carbon and nitrogen flows within agricultural systems.

In order to reduce GHG emissions from farm operations, comply with climate change related legislation, including the above, and where appropriate, implement the following beneficial management practices.

**Energy Conservation and Fuel Switching**

Minimizing energy use will reduce GHG emissions, particularly when fossil fuel use is reduced. For energy intensive production systems, improved energy efficiency has the potential to yield substantial cost savings. The choice of fuel/energy source is also important. For example using electricity, where possible, instead of fossil fuels has a significant positive impact on GHG emissions as outlined in Table 12.1 below.

<table>
<thead>
<tr>
<th>Fuel type / Energy type</th>
<th>Type of use</th>
<th>GHG emissions (metric)</th>
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<tbody>
<tr>
<td>Diesel</td>
<td>IC engine *</td>
<td>2.7 kg CO₂ / litre</td>
</tr>
<tr>
<td>Gasoline</td>
<td>IC engine *</td>
<td>2.3 kg CO₂ / litre</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>Boiler</td>
<td>49.7 kg CO₂ / GJ</td>
</tr>
<tr>
<td>Light Oil</td>
<td>Boiler</td>
<td>2.8 kg CO₂ / litre</td>
</tr>
<tr>
<td>Heavy Oil</td>
<td>Boiler</td>
<td>3.1 kg CO₂ / litre</td>
</tr>
<tr>
<td>Propane</td>
<td>Boiler</td>
<td>1.5 kg CO₂ / litre</td>
</tr>
<tr>
<td>Electricity (BC)</td>
<td>Any</td>
<td>0.027 kg CO₂ / kWh</td>
</tr>
</tbody>
</table>

* IC engine means Internal Combustion engine, for example a normal diesel tractor engine

Implement the following practices to improve energy conservation:

- conduct an on-farm energy assessment to highlight opportunities for energy efficiencies
- check for efficiency rebate and incentive programs from your local utility provider
- use energy-efficient equipment and operating practices
- use minimum till or no-till soil management practices
- maintain engines in efficient running order
- replace existing space heating infrastructure with solar-thermal, geothermal or biomass heating systems
- use appropriately sized and efficiently operated heating and cooling systems for greenhouse and other production facilities

![www.farm-energy.ca](www.farm-energy.ca)
• use timers, sensors or variable speed drives on ventilation, heating, cooling and lighting systems that do not need to operate continuously
• implement thermal energy efficiency improvements that increase insulation
• ensure solid biomass fuels have optimum moisture content
• implement rigorous maintenance programs for all heating system components, particularly for solid fuel biomass boilers
• implement low energy lighting systems where appropriate
  ♦ replace PTO powered equipment and diesel generators with electrical pumps and engines
• ensure that when converting to electrical drive, engines meet the efficiency requirements of Canada’s Energy Efficiency Act
  [http://oee.nrcan.gc.ca/regulations/product/electric_motors.cfm?attr=0](http://oee.nrcan.gc.ca/regulations/product/electric_motors.cfm?attr=0)

On-Farm Renewable Energy Production

Renewable energy is energy produced from naturally occurring sources that are regenerative or theoretically inexhaustible. Sources of renewable energy include:
  ♦ biomass (i.e. woodwaste, manure, food processing waste, etc.)
  ♦ hydroelectric
  ♦ solar
  ♦ wind
  ♦ geothermal

Renewable energy sources can displace fossil fuel use, reducing GHG emissions on and off-farm. They can also help decrease reliance on energy sources with volatile prices, and create new economic diversification opportunities for agricultural producers.

Opportunities for generating or using renewable energy on-farm will depend on the type and scale of operation as well as its location. Some agricultural producers may decide to generate energy or energy feedstock to sell off farm, while others may generate small quantities of energy in the interest of self-sufficiency and reduced energy costs. Renewable energy technologies suitable for on-farm use include:

**Anaerobic Digestion.** Manure and other feed stocks are broken down in the absence of oxygen and methane rich gas is produced and captured for use in a boiler, co-generation facility or upgraded to natural gas for grid injection.

**Electricity.** Electrical power is usually generated by utilizing steam produced from fossil fuel combustion, heat released from nuclear reactions, or from other sources such as wind or flowing water (hydroelectric). In BC, about 80 per cent of the province’s electricity is produced by hydroelectric generation stations located on the Columbia and Peace Rivers. Hydroelectricity is a renewable energy source which releases negligible amounts of GHGs that contribute to climate change and is therefore a preferred source of power in BC.

**Geothermal Systems.** Also known as Ground Source Heat Pumps, pump heat to or from the ground. They use the Earth as a heat source in the winter or a heat sink in the summer to either provide heat or cooling.
Gasification. A self-fuelled process where carbon rich feed stocks, such as manure and wood waste, are converted into a gas at high temperatures in an oxygen starved chamber. The produced gas, called syngas, is then burned to produce heat and electricity through co-generation or just heat via final combustion in a thermal oxidizer.

Wind. Energy from wind is converted to electricity via propeller blades that turn a generator.

Solar. The sun’s energy is converted to electricity via photovoltaic cells (PV) or captured as heat (Solar Thermal).

Hydroelectric. Energy from running water is converted to electricity via small scale hydro power facilities, such as run-of-river projects.

Pyrolysis. A carbon rich feed stock, such as manure or wood waste, is converted to oils and high value chemicals at high temperatures (but lower than gasification) in an oxygen starved chamber.

Biofuel. A fuel produced from crops or crop residues resulting in fuels like bio-diesel and ethanol.

An Overview of On-Farm Biogas Production
Feasibility Study – Anaerobic Digester and Gas Processing Facility in the Fraser Valley, British Columbia
Feasibility Study – Biogas upgrading and grid injection in the Fraser Valley, British Columbia
On-Farm Hydroelectric Generation
www.bcfarmbiogas.ca
www.bcagclimateaction.ca
www.farm-energy.ca

On-Farm Energy Production Regulatory Requirements. Some on farm energy systems may be subject to regulation under the Agricultural Waste Control Regulation which sets emission standards and testing requirements for boilers and heaters fuelled by biomass.  see Climate Change Legislation, page 12-8

Comply with all applicable legislation prior to the initiation of on-farm energy generation facilities. Contact the following agencies which will evaluate projects on a case-by-case basis for specific regulatory requirements and/or required authorization:

♦ Agricultural Land Commission if the proposed facility is within the Agricultural Land Reserve
♦ Regional District to enquire if an amendment to the solid/liquid waste management plan is required
♦ Municipality to enquire if there are applicable bylaws or if amendment to current agricultural zoning is required
♦ Ministry of Environment, Environmental Management Branch to enquire if an operational certificate or waste discharge authorization is required
♦ Environmental Assessment Office to enquire if the proposed project is of large scale,  See Climate Change Legislation, page 12-8
Cropping Practices and Carbon Sequestration

Agricultural ecosystems hold substantial carbon reserves, primarily in soil organic matter. Certain farm practices can facilitate increased storage of carbon or reduce the loss of stored carbon. This is known as carbon sequestration. Various cropping, nutrient, and tillage management strategies can increase sequestration and reduce GHG emissions.

Implement the following practices to increase on-farm carbon sequestration and reduce GHG emissions:

♦ adopt cropping management practices that increase carbon storage
  • implement crop rotations
  • decrease summer and bare fallow
  • use cover crops
  • grow perennial forages
  • increase soil organic matter
  ➔ see Crops Beneficial Management Practices, page 4-5, and refer to Cover Crops and Crop Rotation
  ➔ see Soil Management Beneficial Management Practices, page 8-9, and refer to Soil Organic Matter Content

♦ adopt nutrient management practices that minimize GHG emissions
  • improve timing and rates for irrigation and fertilization and improve drainage in fields to minimize water logged conditions
   排水管理指南
  • use precision farming applications that reduce fertilizer application and overlap
  • time input application to minimize losses through runoff and leaching
  • reduce the use of excess fertilizer, pesticides and other inputs
  • if manure is the primary nutrient source, determine the rate of application by using the procedures in the 营养管理指南 publication

♦ adopt tillage and residue management practices that increase carbon storage and reduce GHG emissions
  • use reduced or no-till systems
  • avoid burning of crop residues which releases CO₂
  ➔ see Open Burning, page 10-17
  • leave plant residues on the soil surface to build soil organic matter

Agroforestry Practices. Two agroforestry systems that have wide applicability for agricultural producers are integrated riparian management and shelterbelts. These systems can increase carbon sequestration.

Implementation of the following agroforestry practices will increase carbon sequestration:

♦ establish integrated riparian management where areas adjacent to watercourses are planted with planned combinations of trees and plant materials, enhancing habitat and providing select timber and non-timber resources
  ➔ see Riparian Area Beneficial Management Practices, page 11-15, and refer to Riparian Area Management

♦ establish shelterbelts where managed rows of trees, shrubs and/or grasses are planted adjacent to production areas
  ➔ see Buffer Beneficial Management Practices, page 11-8, and refer to Windbreaks and Shelterbelts
where surplus land is available, allow land to revert to native vegetation in either large or small parcels

A Guide to Agroforestry in BC
Planning for Biodiversity: A Guide for BC Farmers and Ranchers

Livestock and Nutrient Management

Livestock and manure management are important contributors to agricultural GHG emissions. Implement the following practices to mitigate GHG emissions from livestock and manure and to sequester carbon:

* select regionally appropriate forages for pastures and grazing land which maximize plant productivity and in turn increases the digestibility of feed resulting in less methane emissions from livestock
* implement rotational grazing preventing overgrazing and maximizing digestibility of forage
* change feeding practices to reduce CH$_4$ released from enteric fermentation by using higher quality feed or adding supplements such as lipids to the diet of ruminants
* manage manure to reduce CH$_4$ and N$_2$O emissions
  * cover manure storage facilities
  * capture and combust CH$_4$ from manure
  * use solid rather than liquid manure handling systems
  * apply manure efficiently to match crop needs
  * avoid manure or fertilizer application while soil is saturated with water
  * make more frequent manure applications at lower application rates using sleighfoot or shallow injection equipment for more efficient use of nitrogen (avoid spreading in saturated conditions)
Climate change adaptation is the response of individuals, groups, industry, and others to actual or anticipated changes in climate. Agricultural producers are accustomed to making decisions with respect to variable weather conditions. However, effective climate change adaptation involves a more systematic assessment and response. Adaptation efforts should minimize risks and reduce vulnerabilities to negative impacts, while making it possible to take advantage of any new opportunities associated with climate change.

**Impacts of Climate Change on Agriculture**

Due to its vulnerability to climatic variability, agriculture will be one of the industries most impacted by climate change in BC. Expected impacts include:
- altered length of growing season
- extreme weather events altering how farming operations manage risk
- increased flooding events in some areas, and increased occurrences of drought in others
- reduced snow pack, hotter summer temperatures, decreased stream flows, increased evaporation leading to shortage of water for irrigation
- rising sea level combined with larger storm surges altering salinity of coastal floodplains

These impacts could lead to serious economic losses for producers. While there is potential for an extended growing season and wider range of viable crops in some parts of the province, it is difficult to gauge the accuracy of current climate models in this regard.

Climate Change Impacts and Adaptation: A Canadian Perspective
http://www.env.gov.bc.ca/epd/climate/about/impacts-bc.htm

**Adaptation Beneficial Management Practices**

To date, efforts to address climate change and agriculture have mostly focused on mitigation efforts. However, there is consensus that the implementation of certain agricultural practices will help farms adapt to the impacts of climate change. For individual farm operations, adaptation entails managing risk and participating in emerging opportunities. Understanding the risks associated with climate change will help ensure that any future investments made in the operation are sustainable. Adopt the following adaptation methods where appropriate to mitigate the risk associated with climate change:
- maximize water use efficiency
• plant crops and crop varieties that are drought tolerant
• re-introduce native grasses for pasturing, which can increase drought tolerance
• implement efficient irrigation and livestock watering systems to maximize water use efficiency
  ➔ see Irrigation Beneficial Management Practices, page 9-19, and refer to Irrigation Systems
  ✪ Key Drought Management Tips
  ✪ Irrigation Management Guide
  ♦ adjust storm water management for heavier runoff
  ♦ use mulches and shading to maintain soil moisture or to alter the soil and aboveground microclimate around crops
  ♦ build soil organic matter to protect soil from erosion and improve moisture retention ➔ see Soil Organic Matter, page 8-19
    • use conservation tillage practices to reduce risk from drought
  ♦ vary stubble heights to trap snow and minimize the effects of runoff
  ♦ implement agroforestry systems such as integrated riparian management and shelterbelts to reduce the effects of extreme weather
  ♦ monitor pests and diseases and utilize integrated pest management methods
  ➔ see Pest Beneficial Management Practices, page 5-4, and refer to Integrated Pest Management
  ♦ use technology (e.g. row covers or crop tunnels), to protect crops from weather damage
  ♦ diversify crop types and varieties within individual farm operations to reduce the risk associated with crop failure
    • plant different varieties to stagger seeding and harvest dates
    • consider growing new varieties that are well suited to the current climatic conditions
  ♦ minimize financial risk through production insurance
  ➔ http://www.bcagclimateaction.ca/resources-section/adaptation/
  ➔ http://www.c-ciarn.uoguelph.ca/
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INTRODUCTION

This appendix gives a summary of legislation and enforcement related to environmental issues, including:

♦ Local Government Bylaws
♦ Provincial Government Legislation
♦ Federal Government Legislation
♦ Enforcement by Regulatory Agencies
♦ What Should a Landowner Do?
♦ Agricultural Waste Control Regulation & Code

Farm operations may be affected by environmental legislation from federal, provincial governments or by bylaws of municipal governments, regional districts or the Islands Trust. Each level of government has its own set of rules for environmental concerns. Compliance with the requirements of one level of government does not automatically ensure compliance with other levels.

The following is an alphabetical listing of legislation with the agency(s) that administer each Act listed. Please note that though a significant number of Acts are listed, not all producers are affected by them and most Acts are very specific and not wide ranging. There may also be Acts not listed here that apply to farm operations.

It is recommended that the actual legislation be consulted for the complete, precise wording.

Visit www.bclaws.ca for online versions of the legislation.

This list is not intended to be a legal interpretation of these Acts. Please refer to a lawyer or legal authority for specific advice.

A.1 LOCAL GOVERNMENT

Under the Local Government Act, regional districts, municipalities and other local governments may make bylaws dealing with a number of matters. Farm bylaws and, where a regulation under section 918 of the Local Government Act has initiated the requirement, those rural land use or zoning bylaws applied to the Agricultural Land Reserve which prohibit or restrict agriculture, require approval by the Minister of Agriculture. Once a section 918 regulation is in place for a particular area, it may authorize local government to enact farm bylaws, and/or require review of the rural land use or zoning bylaws. This review is to determine to what extent the bylaws are inconsistent with the standards established by the minister (under section 916 of the Local Government Act).

The Local Government Act gives local governments a wide range of opportunities to apply land use policy and regulation through official community plans (OCP) and bylaws. Because there is a necessity for local bylaws, including official community plans, to be consistent with the Agricultural Land Commission Act, local governments can apply planning policy and bylaw regulation to land in the Agricultural Land Reserve.

Local governments may use a variety of tools to reduce conflicts between agricultural and residential land uses. These tools include policy documents such as official community plans that establish long-term goals to guide development within the jurisdictional boundaries. The guiding principles are enforced by a variety of different bylaws including noise and nuisance, subdivision control, zoning, rural land use and miscellaneous bylaws. Other tools include the designation of development permit areas in official community plans, water drainage plans, and a variety of other planning and policy documents such as park and recreation plans, transportation plans.
plans and neighbourhood plans. Many local governments have conducted agriculture plans that aim to address the needs of the agriculture industry within the local government’s jurisdiction.

The number of bylaws affecting agriculture varies with each local government. Bylaws may regulate:

♦ areas within a region or municipality where farming operations are permitted
♦ setback distances from property lines for buildings and production areas, lot coverage, and minimum lot sizes upon subdivision
♦ setback distances of buildings from watercourses
♦ setback distances from watercourses to minimize negative impacts of runoff, to preserve water quality and protect fish and wildlife habitat
♦ storm water management on agricultural lands
♦ landscaping requirements, burning, plant removal in development permit areas or tree cutting
♦ building requirements in flood plains
♦ nuisances, such as excessive noise from farm operations, including scare devices to control birds (if operated outside normal farm practices)
♦ discharge of firearms
♦ emissions of air contaminants from machinery or equipment
♦ well water test requirements, to access adequacy of water supply and draw-down rates on adjacent properties
♦ construction materials, height and location of fences
♦ occurrences of harmful insects and weeds
♦ temporary farm worker housing

Existing operations, not in compliance with a zoning or rural land use bylaw, may be considered “legally nonconforming.” For instance, despite the fact that the use or siting of a building may not conform to current bylaws, the use may continue as a nonconforming use, provided the use is not discontinued for a continuous 6-month period. Note that for agricultural uses this time does not apply if due to seasonal, market or production cycles, the control of disease or pest or for other reasons in Section 911(2) of the Local Government Act.

Bylaw Enacted Codes: Local government may enforce, where proclaimed, various Codes, such as:

♦ Canadian Farm Building Code:
  • Section 3.1.4: requires equipment being fuelled and above ground fuel storage tanks be at least 12 m from any other building or property line
  • Section 4.1.4: requires pesticide storage facilities to be (1) ventilated to the outdoors; (2) accessible from the outdoors only; (3) secured against unauthorized entry; (4) have an impervious floor that is curbed to contain spills; (5) identified with a sign at entrance stating “Danger – Chemical Storage – Authorized Person Only” or words to that effect; (6) separated from all food, feed and water supplies; (7) insulated and have heated cabinets for chemicals requiring frost protection; and (8) separate oxidizing and flammable chemicals

♦ BC Building Code (refer to BC Building Code Regulation):
  • Section 7.6.2: (plumbing) requires measures to ensure backflow prevention
A.2 PROVINCIAL GOVERNMENT

Several government ministries administer Acts that regulate farm practices in BC. The following legislation dealing directly with regulation of some aspect of the agricultural environment is listed alphabetically.

Producers wishing more information about government policies, programs, etc. can obtain them electronically from the individual Ministry Internet web sites. → see C.2 Web Sites, page C-6

Provincial Acts and Regulations are on the BC Laws site. → www.bclaws.ca

Agricultural Land Commission Act
Administered by the Provincial Agricultural Land Commission, this Act requires agricultural land within an Agricultural Land Reserve not be used for non-farm use unless permitted by the Act or its regulations. It takes precedence over, but does not replace other provincial legislation and local bylaws that may apply to the land.

- Section 20(1): restricts the use of land within an agricultural land reserve (ALR) to farm uses unless specified by the Act, the Agricultural Land Reserve Use, Subdivision and Procedures Regulation or the Commission
- Section 20(2): describes the removal of soil or placement of fill as non-farm uses except as designated by regulation
- Section 20(4): indicates the need for notification to the commission when a prescribed use (i.e. fill pads for greenhouses or barns or the production of turf) involves the removal of soil or placement fill

Some designated farm uses identified are:
- the application of fertilizers, mulches and soil conditioners
- the collection, storage and handling of soil amendments in accordance with the Code under the Agricultural Waste Control Regulation
- the production of compost in accordance with the Code under the Agricultural Waste Control Regulation
- the production or application of compost and biosolids in compliance with the Organic Matter Recycling Regulation

Carbon Tax Act
The Carbon Tax Act establishes a carbon tax in BC. Carbon tax is a broad based tax that applies to the purchase or use of fuels, such as gasoline, diesel, natural gas, heating oil, propane and coal, and the use of combustibles, such as peat and tires, when used to produce heat or energy. Carbon tax applies to fuels at different rates depending on their anticipated carbon emissions, and the tax rates are scheduled to change on July 1, 2011 and 2012. Farmers are required to pay carbon tax on fuel purchased or used for farming operations.

Drainage, Ditch and Dyke Act
Administered by MOE, this Act establishes a system for the regulation and authorization of ditches, watercourses, drainages, and dykes in BC.

Drinking Water Protection Act
This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving more than one single-family residence).

- Section 6: requires water suppliers to provide potable water to water users
- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system
The Drinking Water Protection Regulation defines potable water as “water from a domestic water system” as:

- Water that meets the standards prescribed by the regulation and that is safe to drink and fit for domestic services without further treatment.
- no detectable fecal coliform bacteria or Escherichia coli per 100 ml
- no detectable total coliform bacteria per 100 ml for a sample in 30 days
- at least 90% of samples have no detectable total coliform bacteria per 100 ml and no sample has more than 10 total coliform bacteria per 100 ml for more than one sample in 30 days
- limits on chemical and physical parameters (such as nitrates and heavy metals)

Guidelines for Canadian Drinking Water Quality

Environment and Land Use Act

Administered by MOE, this Act establishes the Environment and Land Use Committee which recommends programs to increase environmental awareness, ensures that the natural environment is considered in land-use and resource development decisions, etc. The Minister of Environment traditionally chairs the committee. Orders may be made respecting the environment or land use that may override other Acts and regulations.

Environmental Management Act (formerly the Waste Management Act)

This Act empowers MOE to control pollution within BC. Waste is defined to include “air contaminants, litter, effluent, refuse, biomedical waste, hazardous wastes” and any other substance designated by Cabinet. Pollution is defined in the Act as “the presence in the environment of substances or contaminants that substantially alter or impair the usefulness of the environment.”

Section 6 of the Act has statements of particular interest to agricultural producers:

- Section 6(2): states that “...a person must not, introduce or cause or allow waste to be introduced into the environment in the course of conducting an industry, trade or business”
- Section 6(3): states that “...a person must not introduce or cause or allow to be introduced into the environment, waste produced by a prescribed activity or operation”
  - note that the Agricultural Waste Control Regulation allows ‘agricultural operations’ exemption of both 6(2) and 6(3): – refer to the Regulation below and Appendix A5, page 270
- Section 6(4): states that “a person must not introduce waste into the environment in such a manner or quantity as to cause pollution
  - ‘agricultural operations’ are not exempt from this requirement
- Section 6(5): states that “nothing in this section or in a regulation……prohibits”
  - (6)(e): the burning of leaves, foliage, weeds, crops or stubble for domestic or agricultural purposes or in compliance with the Weed Control Act
  - (6)(i): emission into the air of soil particles or grit in the course of agriculture or horticulture
- Sections 39 to 64: concern contaminated sites

On-farm processing, handling and sale of agricultural produce may be defined as “agricultural operations” and, if they generate wastes (such as waste water, cull vegetables etc.), may require a Approval, Permit or Operational Certificate from MOE.

Agricultural activities are subject to several Regulations under this Act:

1. **Agricultural Waste Control Regulation.** This Regulation (also under the Public Health Act) applies to ‘agricultural operations’. Within this Regulation, the Code of Agricultural Practice for Waste Management describes agricultural practices for using, storing and managing agricultural waste in a manner that is environmentally sound. The full Regulation and Code under the Agricultural Waste Control Regulation is found in Appendix A.6.
Producers who operate in compliance with this Code do not have to hold an Approval, Permit or Operational Certificate under the Environmental Management Act to discharge ‘agricultural wastes’ into the environment (i.e. it offers exemption of Sections 6(2) and 6(3) of the Act). Compliance with the Code under the Agricultural Waste Control Regulation does not exempt a producer from any other part of the Act. Handling agricultural wastes in a manner not outlined in the Code requires an Approval, Permit or Operational Certificate under the Act.

2. Antisapstain Chemical Waste Control Regulation. This Regulation prohibits the use of woodwaste contaminated by substances, such as antisapstain chemicals, preservatives etc. from being used as mulch or for burning in residential fireplaces or stoves or for fuel for wood-fired boilers, etc.

3. Code of Practice for Soil Amendments. This Code of Practice regulates the use of industrial wastes or by-products such as lime, ash and biosolids as soil amendments. The code provides requirements for maximum concentrations of heavy metals and other contaminants. A land application plan is required if more than 5 m³ of soil amendments, regulated under the Code of Practice, are to be applied to a site in a year. If soil amendments are to be applied to land within the Agricultural Land Reserve, notice must be given to the Provincial Agricultural Land Commission 30 days prior to discharge.

4. Contaminated Site Regulation. This Regulation allows for the identification, evaluation of remediation options, including off-site mitigation of contaminated groundwater, and monitoring of the remediation process of contaminated sites. It covers agriculture only when contaminated materials are brought onto the site or contaminants identified under the regulation leave the site or there is a land use change away from agriculture.

5. Hazardous Waste Regulation. This Regulation (renamed from Special Waste) applies to the management of waste oil, waste pesticides, waste pesticide containers and contaminated soils. Pesticide containers that are rinsed according to the Hazardous Waste Regulation are not considered hazardous wastes. This regulation does not apply to a quantity of hazardous waste which is less than 5 kilograms or 5 litres and which is accumulated or produced in a period of less than 30 days.

6. Municipal Sewage Regulation. This Regulation spells out the rules for treating municipal sewage, reusing highly treated sewage effluent and disposing of effluent that cannot be reused. Codes of practice for reclaimed water use in agriculture are outlined.

7. Mushroom Composting Pollution Prevention Regulation. This Regulation requires that air contaminants from a mushroom composting facility must not be discharged in a manner that causes pollution. Conditions must be met regarding pollution prevention planning, facility design and operation, and reporting.

8. Open Burning Smoke Control Regulation and Code of Practice. There are specific standards and exemptions under the Open Burning Smoke Control Regulation and Code of Practice for various materials burned on the farm. A waste discharge approval or permit for burns is not required under this Act for:
   ♦ agricultural burning of leaves, crops, weeds, foliage or stubble
   ♦ residential (i.e., backyard) burning of leaves, foliage, weeds, crops or stubble
   ♦ burns that satisfy all the terms and conditions set out in the Open Burning Smoke Control Regulation and the Open Burning Smoke Control Code of Practice
   ♦ burns conducted to comply with the Weed Control Act

All other burns (e.g. household, industrial) require a waste discharge approval or permit from MOE. Note: Metro Vancouver is the agency that gives approvals within its boundaries. Even though permitted, open burning must not pollute the air. Schedule A provides a list of materials that are prohibited from being open burned.
The *Open Burning Smoke Control Regulation* requires a burn operator to:

- explore all possible options to reduce, reuse or recycle as much of the material as possible
- burn only vegetative matter such as tree branches, limbs, roots, shrubs, etc.
- burn only on the same site from which the material was gathered and not include material from offsite
- do not burn prohibited materials, or substances that normally emit dense smoke or noxious odours
- burn the material more than 100 m from a neighbouring residence or business and more than 500 m from a hospital, continuing care facility, or school that is in session
- ensure that smoke from open burning does not pose a hazard at airports or highways by significantly reducing visibility
- ensure that the ventilation index is "good" on the day the burn is started and forecast to be "good" or "fair" on the following day (see the regulation for further information and requirements)
- ensure satisfactory control and feeding of the fire, and make sure adequate equipment and staff are available to ensure the regulatory limits are met
- follow all of the burning restrictions that are relevant to the sensitivity zone
- these restrictions include a smoke release period of either 72 or 96 hours, and restrictions on the number and frequency of burns per year

9. **Organic Matter Recycling Regulation.** This Regulation (also under the *Public Health Act*) deals with the production of compost and subsequent land application of recyclable organic matter derived from many non-agricultural (municipal) sources (i.e., sewage biosolids, yard waste and food waste). It is intended to encourage composting and beneficial use of selected organic matter. The regulation contains quality criteria for metals, pathogens and vector attraction reduction. It also covers aspects of land application plans for managed organic matter. It does not apply to agricultural waste composting operations that operate in accordance with the *Agricultural Waste Control Regulation*. Schedule 12 of the *Regulation*, lists suitable organic material for composting under provisions of the *Regulation* and provides some definition of the source and constituents of those organic materials.

**Class A Compost:** Section 12 of the Regulation specifies the requirements for Class A compost. Compost that is produced solely from yard waste or untreated and unprocessed wood residuals must meet pathogen reduction process and vector attraction reduction requirements and quality criteria (trace elements).

Compost that contains any of the other permitted organic materials (Schedule 12) must additionally meet pathogen reduction limits and must meet sampling and record keeping requirements as outlined in Schedules 5 and 6 of the OMRR. If the compost meets these requirements, it is considered Class A compost and it can be distributed freely without volume restriction.

To be designated as Class A compost, fecal coliforms must be measured at less than 1000 MPN per gram of total solids (dry weight basis). If compost is made from yard waste alone, determination of fecal coliform levels is not required. Class A compost must also meet the quality criteria as outlined in Schedule 4, column 1.

10. **Ozone Depleting Substances and Other Halocarbons Regulation.** This Regulation regulates the servicing of refrigeration equipment and disposal of refrigerant gases.

11. **Spill Reporting Regulation.** This Regulation requires reporting of spills:

- **Section 2(1):** A person who had possession, charge or control of a substance immediately before its spill shall immediately report the spill to the Provincial Emergency Program (PEP) by telephoning 1-800-663-3456 as provided in section 12(5) of the Act or, where it is not practical to report to PEP within a reasonable time, to the local police or nearest detachment of the Royal Canadian Mounted Police.
- **Section 2(2):** Where it appears to a person observing a spill that a report under subsection (1) has not been made, he or she shall make the report referred to in this section.
2(3) A report under this section shall include, to the extent practical,
(a) the reporting person's name and telephone number,
(b) the name and telephone number of the person who caused the spill,
(c) the location and time of the spill,
(d) the type and quantity of the substance spilled,
(e) the cause and effect of the spill,
(f) details of action taken or proposed to comply with Section 3,
(g) a description of the spill location and of the area surrounding the spill,
(h) the details of further action contemplated or required,
(i) the names of agencies on the scene, and
(j) the names of other persons or agencies advised concerning the spill.

- Section 3: Where a spill occurs, the person who immediately before the spill had possession, charge or control of the spilled substance shall take all reasonable and practical action, having due regard for the safety of the public and of himself or herself, to stop, contain and minimize the effects of the spill.

The Regulation requires reporting any spill of pesticide greater than five kilograms or five litres, fertilizer (including manure) greater than 50 kilograms or 50 litres and petroleum products greater than 100 litres, and any polluting substance greater than 200 kilograms (such as manure or mortalities). Check the regulation for other specific substances and reportable quantities.

12. Waste Discharge Regulation. This Regulation regulates various industries and their waste discharges into the environment. It exempts industries who discharge wastes in accordance with applicable codes of practice from Section 6(2) and (3) of the Environmental Management Act (as the Agricultural Waste Control Regulation does for agriculture with the Code of Agricultural Practice for Waste Management).

Farm Practices Protection (Right to Farm) Act
Administered by AGRI, this Act provides that farmers on agricultural land are not liable to legal actions resulting from nuisance complaints regarding farming activities when they meet certain conditions. The Act defines a normal farm practice as an activity “that is conducted by a farm business in a manner consistent with proper and accepted customs and standards as established and followed by similar farm businesses under similar circumstances”:
- Section 2: protects a farmer from liability in lawsuits alleging nuisance for odour, noise, dust or other disturbance resulting from a farm operation if
  - the farmer uses normal farm practices
  - the operation is conducted in the ALR, land zoned for farm use, or, in the case of fish farming, has a valid license under the provincial Fisheries Act
  - there is no contravention of other listed legislation, such as the Environmental Management Act, the Agricultural Waste Control Regulation and Code of Agricultural Practice for Waste Management and land use regulations (e.g. a zoning bylaw)

In addition, the Act establishes a Farm Industry Review Board to receive complaints regarding odour, noise, dust or other disturbances resulting from farm operations. The Farm Practices Board will hear complaints and determine whether the complaint issue results from a normal farm practice.
http://www.agf.gov.bc.ca/resmgmt/fppa/refguide/intro.htm

Fish Protection Act
The Fish Protection Act enables the protection of fish and fish habitats. The four main objectives of the Act are to ensure sufficient water for fish, enable fish habitat to be protected and restored, improve riparian habitat protection and enhancement, and give local governments greater powers for environmental planning. The Fish Protection Act provides legislative authority for water managers to consider impacts on fish and fish habitat before approving new licenses, amendments to licenses or issuing approvals for work in or near streams. Only parts of the FPA have been brought into force, they are:
Section 4: prohibits new dam construction on specified major rivers

Sections 6 & 7: allow sensitive streams designation and recovery plans
- such streams will have restrictions requiring the consideration of fish flow requirements placed on new water licenses or approvals, or amendments to existing, until the stream has recovered

Section 9: In the case of drought, for the purposes of protecting the fish population, the minister may make temporary orders regulating the diversion, rate of diversion, time of diversion, storage, time of storage and us of water from the stream by holders of licences or approvals in relation to the stream.

Section 12: requires municipal bylaws, where directed, regarding the protection and enhancement of riparian areas that may be subject to residential, commercial or industrial development
- the requirements do not apply to “agriculture” activities, they do apply to new residential, commercial, or industrial development or ancillary activities on land zoned for agricultural purposes. Guidelines for agricultural activities are in the Environmental Farm Plan series publications.

Riparian Areas Regulation. This Regulation, under the Fish Protection Act establishes directives to protect riparian areas from development and to facilitate cooperation between DFO and the Union of BC Municipalities. It applies to the exercise of local government powers under the Local Government Act. The Regulation provides required riparian assessment methods by Qualified Environmental Professionals as a condition of approval for new residential, commercial, or industrial activities.

Sensitive Stream Designation and Licensing Regulation. This Regulation (also under the Fish Protection Act) applies to licences and approvals on sensitive streams, and lists streams designated – 15 streams to date, on eastern Vancouver Island, lower Coast, and lower Fraser Valley (see the Regulations’ Schedule).

Fisheries Act
The Fisheries Act provides for licensing and regulatory control of activities associated with commercial fisheries and aquaculture operations, this Act deals with licensing of fisheries, processors and safe fish passage:
- Section 28: requires fish protection devices for any dam or other hydraulic work
  - this may include fish ways, screens, etc.

These requirements are also provisions of the Federal Fisheries Act and the Provincial Fish Protection Act and are most likely to be enforced by the agencies responsible for those Acts.

Private Managed Forest Land Act
This Act allows the Private Managed Forest Land Council to be responsible for private managed forest land other than land that is in a tree farm licence area, a woodlot licence area or a community forest agreement area with respect to inclusion, exclusion, subdivision and non-forestry uses. In addition, the Council is responsible for ensuring that forest management practices, including agroforestry, on private land within the FLR complies with prescribed environmental standards of forest practice for the protection of fish habitat, water quality, soil conservation and critical wildlife habitat.

Forest and Range Practices Act
This Act regulates all forest practices (which include grazing on Crown lands). To replace the Forest Practices Code of British Columbia Act.

Forest Practices Code of British Columbia Act
This Act regulates all forest practices (which include grazing on Crown lands). The Act is superseded by the Forest and Range Practices Act.
**Game Farm Act**
Administered by AGRI, this Act licences and regulates game farms.
♦ Section 6: states Section 76 of the *Wildlife Act* does not apply to game that escapes from a farm being operated by a person who holds a valid licence (but the *Game Farm Regulation* limits this by requiring capture within 30 days and other conditions, such as genetic integrity of wildlife)

**Greenhouse Gas Reduction (Cap and Trade) Act**
The Act provides the legislative authority to implement a cap-and-trade system for GHGs which includes the establishment of reporting and compliance requirements. It also provides authority for regulations to establish criteria for projects that qualify as GHG offsets in a regulated offset system.

Single sites which emit 10,000 tonnes or more of CO₂ per year have to report their emissions, and those which emit 25,000 tonnes or greater will be regulated. There is currently only one agricultural facility in BC which emits over 25,000 tonnes per year and a few that emit more than 10,000 tonnes which are required to report their emissions.

**Greenhouse Gas Reduction Targets Act**
The Act commits British Columbia to reductions of GHG emissions (of 2007 levels) by at least 33% by 2020. By 2050 it commits British Columbia to reductions (of 2007 levels) by at least 80%. Although emissions reductions for agriculture are not regulated, if agricultural emissions are not reduced while the rest of society does, the perceived impact of agriculture’s contribution to climate change will increase.

Under the Act, public sector organizations are required to be carbon neutral by 2010. Through the Climate Action Charter (separate from the Act), a large number of Local Governments have agreed to become carbon neutral and can develop municipal Climate Plans to mitigate emissions. Through this process Local Governments may encourage reduction of agricultural GHG emissions in the municipality.

**Emission Offsets Regulation**
The *Regulation* sets out the requirements for greenhouse gas reductions and removals from projects or actions that qualify as emission offsets for the purpose of fulfilling the provincial government’s commitments to be carbon neutral by 2010.

**Integrated Pest Management Act** (formerly the *Pesticide Control Act*)
Administered by MOE, this Act regulates the sale, containment, transportation, storage, preparation, mixing, application and the disposal of pesticides and their containers.
♦ Section 4(1): Except as provided in the regulations, a person must not … use a pesticide for a prescribed use unless the person holds the licence that is, under the regulations, required for that purpose, and complies with the terms and conditions in or attached to that licence

**Integrated Pest Management Regulation**
♦ Section 5: describes the uses of pesticide which are considered to be prescribed for the purposes of the Act
  • the management of vegetation on not more than 20 ha a year of private land that are used for a facility or right of way for the delivery of water or a pipeline, as defined in the Petroleum and Natural Gas Act, and associated facilities, and managed by a single entity
  • the management of mosquitoes, using a bacterial pesticide, on not more than 1 ha a year of private land that is a body of water, and managed by a single entity
  • the management of forest pests on private land used for timber production, including private roads, roadsides and other areas ancillary to the timber production
• the management of noxious weeds or invasive plants on not more than 50 ha a year of public land managed by a single entity

♦ Section 18(1): Permit-restricted pesticides are considered to be prescribed for the purpose of the Act
♦ Section 18(2): Except as provided in subsection (4), the following uses of a pesticide are prescribed for the purpose of the Act
  • aerial application of a pesticide
  • use of a pesticide, other than an excluded pesticide, in or on a body of water, unless a licence is required for the use or a confirmation is required for the use
♦ Section 18(4): A use described in subsection (2) is not prescribed if
  • the use is aerial application to private land used primarily for agricultural production, the use is aerial application of a Scheduled Pesticide, in accordance with a licence or a confirmation, and to land that is neither in an urban area nor used for residential purposes

♦ Section 33(1): A person who stores a pesticide must store it in a manner that
  • minimizes hazards to human health and the environment, and
  • is in accordance with the standards prescribed in Sections 65 [pesticide container and labeling standards], 66 [pesticide storage] and 67 [pesticide storage — licencsee], as applicable
♦ Section 33(2): A person who transports or causes or allows the transport of a pesticide must ensure that the pesticide is secured and transported in accordance with the applicable standards prescribed in Division 7 [Standards for Use, Containment, Transport, Storage or Sale of Pesticide] of Part 2 and in a manner that prevents
  • the escape, discharge or unauthorized removal of the pesticide from the transport vehicle, and
  • the contamination of food or drink intended for animal or human consumption, bedding or similar items that are transported with the pesticide
♦ Section 33(3): A person who uses a pesticide must use it in a manner that
  • minimizes hazards to human health and the environment, and
  • is in accordance with the applicable standards prescribed in Division 7 [Standards for Use, Containment, Transport, Storage or Sale of Pesticide] of Part 2 in relation to the handling, mixing, applying or disposing of pesticides, and the handling and disposal of containers used for pesticide

♦ Section 65(1): Pesticide must be kept, handled, stored or transported
  • in the container in which it was originally packaged and with the label originally affixed by the manufacturer, or
  • in a container designed for containing the pesticide and labeled in accordance with subsection (2)
♦ Section 65(2): For the purposes of subsection (1)(b), a label must display
  • the trade name of the pesticide,
  • the name and the concentration of the active ingredient in the pesticide, and
  • the pesticide's registration number under the federal Act
♦ Section 65(3): Subsections (1) and (2) do not apply to tanks being used for mixing pesticides for or holding pesticides during use
♦ Section 66(1): Pesticide, other than excluded pesticides and domestic pesticides, must be stored
  • separately from food intended for human or animal consumption, and
  • in a storage facility that is ventilated so that pesticide vapours are vented to the outside, not used for the storage of food intended for human or animal consumption, locked when unattended, and accessible only to persons authorized by the person storing the pesticide
♦ Section 66(2): Each door providing access to a facility described in subsection (1) must bear a sign that
  • has the words "warning: chemical storage — authorized persons only" written in block letters, and
  • is clearly visible to a person approaching the door
♦ Section 66(3): Fumigants and other pesticides that
  • release vapours, and
  • bear a "poison" symbol on the label and must be stored in a storage facility that is not attached to or within a building used for living accommodation
Section 70(1): A container used to prepare, mix or apply a pesticide must not be washed or submerged in a body of water.

Section 70(2): If equipment is used to draw water from a body of water or an irrigation system into a container used to contain, prepare, mix or apply a pesticide, a gap must be maintained between the pesticide and the equipment so that pesticide is prevented from entering the body of water or irrigation system.

A summary of the Integrated Pest Management Act and Regulation can be found at http://www.env.gov.bc.ca/epd/ipmp/regs/index.htm

The Integrated Pest Management Act and Regulation establish conditions for the sale and use of pesticides in British Columbia through a classification system and regulatory provisions for licences, certification, permits, Pest Management Plans and ministry confirmations of receipt of a pesticide use notice. The Regulation also contains public notification, consultation, reporting, and record keeping provisions – as well as standards for use of Integrated Pest Management and for human health and environmental protection.

Under the IPM Act, a person must not “use, handle, release, transport, store, dispose of or sell a pesticide in a manner that causes or is likely to cause an unreasonable adverse effect.” This general prohibition, in concert with requirements for Integrated Pest Management (IPM), underpins the ministry’s approach to regulation of pesticide use in British Columbia.

The IPM Act and Regulation establish classes of pesticides, and requirements for licences, certification, permits and pesticide use notice (PUN) confirmations for each class. The classification system utilizes definitions and labeling for sale and use of pesticides set out in the federal Pest Control Products Act.

The five Pesticide classes under the IPM Act are:

- **Permit-restricted**: these pesticides are listed by name in the regulation; they are the most strictly controlled, requiring a permit for purchase or application
- **Restricted**: these pesticides have the Restricted product class specified on their label; a pesticide applicator certificate is required for their purchase or use
- **Commercial**: these pesticides have the Commercial product class specified on their label
- **Domestic**: these pesticides have the Domestic product class specified on their label; they are intended for use by non-professionals in or around private homes and gardens
- **Excluded**: these pesticides are listed by name or type of use in the regulation; their use or sale does not require a licence, certificate, permit or confirmation; they are assigned to this class because the Administrator considers that excluding them from requirements for a licence, permit or confirmation will not increase the risk of unreasonable adverse effects

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**Land Act**

This Act administers and regulates Crown land disposition, grants and trespass.

Section 67(1) states a person must not throw, deposit, dump or in any way cause to be placed on Crown land any glass, metal, garbage, soil or other substance without the authority of the minister.

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**Local Government Act**

Administered by the Ministry of Community, Sport and Cultural Development, this Act provides the legislative framework for the establishment, function and operation of local governments. It provides for the authority for local government to establish rules and regulations and for the provision of services to the local community. Several sections may apply to the environment:

- Section 692: allows regulations for a Provincial building code that applies to all municipalities and regional districts as an enacted bylaw (refer to BC Building Code Regulation next page)
- Sections 875 to 884: relate to official community plans – these may restrict the use of land that is environmentally sensitive to development and provide for the designation of development permit areas in plans (see also section 920) for various purposes including the protection of the natural environment and the protection of farming.
♦ Sections 903 to 914: relate to zoning bylaws that may be adopted
♦ Section 907: allows bylaws to control runoff related to the construction of a roofed area or paved area and to establish the maximum percentage of the area of land that can be covered by impermeable material
♦ *Sections 915 to 919: outline the use of land for agricultural operations; Section 916: allows for bylaw standards; Section 917: provides for farm bylaws
♦ Section 920: provides the authority to issue development permits relating to the protection of the natural environment and the protection of farming

*Note that under Section 918 and 903(5) -zoning bylaws- and Section 917-farm bylaws- do not apply until the Lieutenant Governor in Council, by regulation, declares that they apply. These provisions require that, for land in an Agricultural Land Reserve (ALR), a rural land use bylaw or zoning bylaw which prohibits or restricts the use of land for a farm business, or a farm bylaw, must be approved by the Minister of Agriculture and Lands

Stewardship Options for Private Landowners in BC
Guide for Bylaw Development in Farming Areas (this provides information on the Minister’s standards, the review of zoning and rural land use bylaws and the development of farm bylaws)

BC Building Code Regulation. This regulates residential building and plumbing.
♦ Section 2: adopts the 1995 National Building Code of Canada as the BC Building Code (note the Plumbing Services section which is part of the Building Code, contains requirements for backflow prevention)

Motor Vehicle Act
Administered by Ministry of Transportation and Infrastructure, this Act makes deposition or dumping of “noxious, nauseous or offensive matter” (e.g. the carcass of a dead animal, offal, ashes, refuse) on a highway or right-of-way an offence.

As of October 1, 2010, in accordance with the Motor Vehicle Act, heavy diesel vehicle emission control devices must be installed on all BC registered commercial diesel vehicles of model years 1989-1993 with a Licensed Gross Vehicle Weight (LGW) of more than 8,200 kg. Farm vehicles with a LGVW under 17,300 kg are exempt from these retrofit requirements.

Plant Protection Act
Administered by AGRI, this Act is the provincial counterpart to the federal Plant Protection Act that focuses on plant protection issues affecting Canada. It provides for the prevention of the spread of pests destructive to plants in BC. Inspectors have powers to enforce the provisions of the Act, including the authority to establish quarantine areas. To assist in the enforcement of the Act, the BC Plant Protection Advisory Council advises and co-ordinates the actions of provincial and federal officials to deal with potential hazards to BC agriculture and forestry from insects, plant diseases, weeds or other biotic agents. The Council’s power comes from the mandates of the agencies whose members sit on committees struck to deal with plant protection issues in specific commodity sectors.

Public Health Act
Administered by the Ministry of Health Services, this Act includes regulations on farm practices that may result in a health hazard. A health hazard may occur when nutrients, contaminants or pathogens are discharged to land, water or air to pose a public health problem. Spills of potentially harmful substances must be reported to the Local Health Authority. Under this Act, the Local Health Authority must investigate any health hazard and has authority to order the hazard to be eliminated.

Food Premises Regulation. This Regulation applies to any place where food intended for public consumption is sold, offered for sale, handled, prepared, packaged, processed, stored, etc. Food premises must be connected to a source of potable water and be connected to a waste disposal system, among other requirements.
♦ Section 4: contains food premises requirements
Section 14: contains food processing requirements

Public Health Act Transitional Regulation. Section 18 regulates to setback distances for wells. Section 18: requires a separation distance from wells to be at least

- 7 m from any dwelling house (grandfathered)
- 30.5 m from any probable source of contamination (many farm activities and wastes)
- 122 m from any cemetery or dumping ground unless, owing to the physical conformation, contamination of the well is impossible

Sewerage System Regulation. This Regulation applies to domestic sewage disposal systems.

- Section 2: states Regulation applies to a holding tank, single family residence or duplex, with a daily flow of less than 22,700 litres
- Section 3: requires domestic sewage be discharged into a public sewer, a holding tank or a sewerage system so as not to cause, or contribute to, a health hazard
- Section 3.1 requires separations distances from wells (as outlined in the Sewerage System Standard Practice Manual) to be at least:
  - 15 m from a holding tank
  - 30 m from a sewerage system
- Sections 4 and 5: regulate holding tanks
- Sections 6 to 10: regulate sewerage systems
  - only an authorized person can construct and maintain systems (having taken training)
  - applies to new systems, or existing ones under going significant alteration or repair
  - the owner is responsible to have maintenance done and to keep records

Transportation of Dangerous Goods Act

Administered by Ministry of Attorney General, this Act establishes requirements to provide for the safe transport of goods deemed to be dangerous. Regulations specify substances and establish classes of dangerous goods.

Water Act

Under this Act, using surface water requires a licence, and working in and around streams requires an approval from Front Counter BC. A stream is defined as any natural watercourse or source of supply, whether usually containing water or not. Streams include groundwater and any lake, river, spring, swamp, creek or ravine. Although at the present time a water licence is not required to use groundwater, groundwater legislation may be forthcoming.

The right to take specified quantities of water from a stream for designated purposes and construct and maintain water works on private or Crown Land is given by a water licence. Water licences also document water use and establish priority rights to available supply. Water licences may be cancelled for several reasons, including failure to follow the terms and conditions of the licence, termination of use of the water and negligence in keeping water rental payments in good standing. Some sections of interest:

- Section 2: vests the property and right to use water with the government except private rights under licences or approvals under the Act
- Sections 5 & 6: list the rights acquired under a water licence
- Section 7: lists who may acquire a water licence (issued by Front Counter BC)
- Section 8: allows short term approvals (water use less than 12 months)
- Section 9: allows approvals for changes in and about a stream; these must also meet with DFO approval under the Federal Fisheries Act (see also the Water Regulation, Part 7, next page)
- Sections 10 – 50: outline license applications, rights, administrative concerns, rights of appeal, offences, water users’ communities
- Sections 62 – 67: gives the minister the ability to designate an area for the purpose of developing a water management plan to address or prevent:
♦ conflicts between water users
♦ conflicts between water users and instream flow requirements, or
♦ risks to water quality
♦ Sections 68 to 82: provide for ground water protection (see also *Ground Water Protection Regulation*, below)

**Understanding a Water Licence**

**Water Rights in British Columbia**

**Water License Holders Rights and Obligations**

**A Users Guide to Working In and Around Water**

**Standards and Best Practices for Instream Works**

**British Columbia Dam Safety Regulation.** The objective of this Regulation is to mitigate loss of life and damage to property and the environment from a dam breach by requiring dam owners to: inspect their dams, undertake proper maintenance, report incidents and take remedial action and ensure that the dams meet current engineering standards.

**Ground Water Protection Regulation.** This Regulation applies to all well pump installers and well drillers in BC. It regulates their registration and qualification and provides for ground water protection regarding well sealing, identification, deactivation, capping, flood proofing of wells with the “Code of Practice for Construction, Testing, Maintenance, Alteration and Closure of Wells in BC”. Requirements came into effect in Nov 2004 and Nov 2005.

**Water Regulation.** This Regulation deals with water rights acquisition, fees, rentals and charges; regulates power developments, expropriation of land by licensees, water districts and changes in and about a stream. Part 7: - outlines how “changes in and about a stream” may be carried out by Notification to MOE rather than by approval, licence or order under Section 9 of the Act
♦ Section 40: authorizes Notification to MOE for certain “changes”
♦ Sections 41, 42, 43: requires protection of water quality, habitat and other water users
♦ Section 44: lists “changes” authorized (not requiring an approval or licence)

**Water Protection Act**

Administered by MOE, this Act will not affect most producers. It:
♦ confirms the ownership of surface water and groundwater in the Province
♦ maintains existing bulk water removal rights
♦ prohibits bulk removal of water to outside BC
♦ prohibits large-scale diversion of water between the major watersheds of BC

**Weed Control Act**

Administered by AGRI, this Act places the responsibility for the control of noxious weeds on the occupiers of the land. It provides for the appointment of inspectors to ensure compliance and, failing that, for a method by which they can control weeds and recover the costs from the occupier. Weed Control Committees may be established by municipal councils to administer the Act within a municipality. Committees report to the municipal council and the Minister.

**Wildfire Act**

As of March 31, 2005, this Act regulates open fires within 1 km of forest land or grass land. It is administered by the Ministry of Forests, Mines and Lands.
♦ Section 2: requires reporting a forest land or grass land fire
♦ Section 3: prohibits dropping, releasing or mishandling a burning substance, or any other thing that the person reasonably ought to know is likely to cause a fire
♦ Section 4: states Section 5 & 6 do not apply to the City of Vancouver or a municipality or a local government having an open fire bylaw
Section 5 & 6: regulates non-industrial and industrial open fires

**Wildfire Regulation.** This Regulation applies to all open fires within 1 km of forest land or grass land.

- Sections 4 – 12: outline fire prevention requirements
- Sections 13 – 17: outline fire control requirements
- Sections 18 – 24: outline permissible open fires (category 1, 2, 3 and resource management fires)
- A burn registration number is required for category 3 fires – call toll free 1-888-797-1717
- Schedule 1: outlines three Danger Regions of BC
- Schedule 2: defines five different Fire Danger Classes using a matrix of Buildup Index and Fire Weather Index
- Schedule 3: provides restrictions on High Risk Activities as required in Section 6(3)

**Category 1 Open Fire.** Camp fires and piles under 1 m in height and diameter

**Category 2 Open Fire.** For open fires that are:
- no more than 2 piles that are less than 2 m in height and 3 m in width
- or burns of stubble or grass over an area not exceeding 0.2 ha

**Category 3 Fires.** For open fires that are:
- burning material in 3 or more piles not exceeding 2 m in height and 3 m in width
- or for 1 or more piles exceeding 2 m in height and 3 m in width
- or for one or more windrows, or for burning stubble over an area exceeding 0.2 ha

www.bcwildfire.ca for fire information including the Fire Danger Class information for areas of BC

**Wildlife Act**

Administered by MOE, this Act protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

- Section 4: allows designation of wildlife management areas
- Section 7: makes it an offence to alter, destroy or damage wildlife habitat within a wildlife management area
- Section 9: makes it an offence to disturb, molest or destroy a muskrat or beaver house, den or dam unless you are a licensed trapper or have lawful authority to protect property or maintain irrigation or drainage facilities
- Section 33.1: makes it an offence to feed dangerous wildlife (bear, cougar, coyote or wolf) unless as approved hunting or trapping
- Section 34: makes it an offence to possess, take injure, molest or destroy the nest of an eagle, peregrine falcon, osprey, heron or burrowing owl or the nest of any bird not mentioned above when the nest is occupied by the bird or its egg
- Section 39: makes it an offence to hunt or trap on cultivated land or on a Crown land grazing lease while occupied by livestock without the lessee or owners consent
- Section 89: gives an officer powers of entry on proof of identification

This Act has been amended by the Fish Protection Act to have wildlife include aquatic plants. Aquatic invertebrates or plants can be considered as endangered or threatened.

**Workers Compensation Act**

This Act has conditions under the Occupational Health and Safety Regulation that pertain to pesticide management:

- Section 6.77(1): requires that a worker who mixes, loads, cleans equipment, or applies moderately or very toxic pesticides hold a valid applicators certificate
- Section 6.93(1): requires that an employer take all reasonable precautions to prevent the drift or spread of a pesticide
Section 6.101: requires that a number of factors be considered when designing pesticide storage; pesticide compatibility, quantity, and containment of spills

**Zero Net Deforestation Act**
The *Zero Net Deforestation Act* was enacted in 2010 and commits British Columbia to achieving no net deforestation in the province by 2015. Deforestation, under the Act, is defined as “the permanent loss of the human-induced removal of trees from an area of forest land to such an extent that the area is no longer forest land.” The Act aims to mitigate greenhouse gas emissions associated with deforestation.

### A.3 FEDERAL GOVERNMENT


**Canadian Environmental Assessment Act**
Administered by the Canadian Environmental Assessment Agency (an independent agency reporting to the Minister of Environment), this Act applies only to federal lands, works (such as federally-funded projects) and undertakings, lands subject to the *Indian Act*, as well as lands in respect of which Indians have interests.

**Canadian Environmental Protection Act**
Administered by Environment Canada with Health Canada, this Act applies to all lands in Canada and concerns toxic substances, hazardous materials, new substances, export and import of substances, fuels, international air pollution, ocean disposal, etc.

**Feeds Act**
Administered by Agriculture and Agri-Food Canada, this Act controls and regulates the sale of animal feeds. The manufacture, sale or importation into Canada of any feed must be registered, packaged and labeled to prescribed standards.

**Fertilizers Act**
Administered by Agriculture and Agri-Food Canada, this Act covers agricultural fertilizers. Fertilizers or supplements may only be sold in or imported into Canada if they have been registered, packaged and labeled to prescribed standards.

**Fisheries Act**
Administered by both Fisheries and Oceans Canada and Environment Canada (also can be administered provincially by MOE), this Act is established to conserve and protect Canada’s fisheries resources, including fish habitat. It applies to all Canadian fisheries waters, including ditches, channelized streams, creeks, rivers, marshes, lakes, estuaries, coastal waters and marine offshore areas. It also applies to seasonally wetted fish habitat such as shorelines, stream banks, floodplains, intermittent tributaries and privately owned land. Provisions for stiff fines and imprisonment are contained in the Act.

Under this authority, the federal *Fisheries Act* plays a significant role in controlling pollution that is deleterious to fish or fish habitat and impacts to habitat. Fish are defined as, shellfish, crustaceans, marine animals; the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals:

- Sections 20, 21, 22: may require fish passage ways be installed, one-half of the costs may be recovered; sufficient flows for fish passage at obstructions
- Sections 27 and 29: prohibit obstructions to fish passage of any fish-way; use of net, weir, or other device that obstructs passage of fish
- Section 30: the need for, and maintenance of, fish screens and fish guards in water intakes, ditches
- Section 32: prohibits the destruction of fish except by fishing
Section 34: has important definitions used in following sections (“deleterious substance”; “deposit”; “fish habitat”)

Section 35: prohibits harmful alteration, disruption or destruction (HADD) of fish habitat
- harmful alteration, disruption or destruction includes any changes in fish habitat that reduces its capacity to support one or more life processes of fish
- fish habitat includes spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes

Section 36: prohibits the deposit of deleterious substances into water frequented by fish either directly or indirectly by placing those substances where they can get into such water. Deleterious substances when added to any water degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water.
- this section is jointly enforced by Environment Canada and Fisheries and Oceans Canada (DFO)
- deleterious substances could include many farm products and wastes

Section 37: requires approval for work that may impact fish habitat
- any work in or about a fish-bearing watercourse requires pre-approval from DFO

Section 38(4): requires reporting infractions of Section 35 or 36

Complying with the Fisheries Act

Food and Drugs Act
The Food Directorate of the Health Products & Food Branch, Health Canada, decides the type and form of food products that can be sold in Canada. It is also responsible for determining the safety of potential residues of agricultural chemicals in food and assessing dietary exposure of the public to agricultural chemicals.

Under the authority of the Act, regulations set maximum residue limits of agricultural chemical residues permissible in both domestic and imported food when it first enters commerce. Food with levels of agricultural chemicals exceeding established maximum residue limits is considered adulterated and the crop may be seized and removed from sale.

Health of Animals Act
The Health of Animals Act enables regulatory control over Specified Risk Material (SRM), so that it does not enter the animal feed system. Regulations under this Act (enhanced feed ban) require that producers do not feed any animal products containing SRM to livestock and that abattoirs properly identify SRM to ensure that it is removed from the feed system. A permit from the Canadian Food Inspection Agency (CFIA) is required to handle, transport or dispose of cattle carcasses and certain cattle tissues. Composting processes do not destroy SRM, therefore composted mortalities must be handled in accordance with CFIA regulations as the compost is still considered to contain SRM.

Migratory Birds Convention Act, 1994
Under this Act, the federal government is responsible for implementing a Convention between Canada and the U.S. for the protection of migratory birds and nests. The Canadian Wildlife Service of Environment Canada administers the regulations.
- Section 5: of the Act states that, no person shall, without lawful excuse,
  - be in possession of a migratory bird or nest; or
  - buy, sell, exchange or give a migratory bird or nest or make it the subject of a commercial transaction except as authorized by the regulations

Under the Regulations:
- Section 6: no person shall: disturb, destroy or take a nest, egg, nest shelter, eider duck shelter or duck box of a migratory bird without permit
Section 24(1): any person may, without a permit, use equipment, other than an aircraft or firearms, to scare migratory birds that are causing, or are likely to cause damage to crops or other property (other control measures require a permit).

Section 33: no person shall introduce into Canada for the purpose of sport, acclimatization or release from captivity a species of migratory bird not indigenous to Canada except with the consent in writing of the Director.

Section 35(1): prohibits the deposit of oil, oil wastes or any other substance harmful to migratory birds in any area frequented by migratory birds.

Migratory waterfowl populations create demands on the use of adjacent agricultural lands. Under the Act, it is an offence to harm the habitat of any migratory bird while the bird is resident at the site or to release any substance (including pesticides) harmful to migratory birds into areas frequented by them.

Native birds not protected by this Act (grouse, quail, pheasants, ptarmigan, hawks, owls, eagles, falcons, cormorants, pelicans, crows, jays and kingfishers) are protected by the Provincial *Wildlife Act*. Introduced species are not protected (European starling, house sparrow and created myna).

**Pest Control Products Act**

Under this Act and its regulations, Health Canada have the authority to regulate pest control products used in agriculture, forestry, industry, public health and domestic situations.

The Act is intended to ensure that no person shall store, display, distribute or use a pest control product under conditions that are unsafe to human or animal health or that will adversely affect the environment.

Pest control products include herbicides, fungicides, insecticides, rodenticides, biological controls such as bacteria and viruses and antimicrobial agents such as those used in wood preservation, water purification systems and material preservatives. The intent of the legislation is to ensure the safety, merit and value of pesticides used in Canada.

Pest control products must be registered in Canada for specific uses and modes of application. This requires health and environmental assessments of impact. Provisions exist in the Act to approve the use of pest control products not registered in Canada for uses registered in the U.S., if no acceptable alternative control is available. The expanded use of registered products for uses not registered on the label may also be granted under specific circumstances.

Pest control products must have Canadian registration to be used legally in Canada. Registered products bear a *Pest Control Products Act* registration number on the label. It is an offence under the Act and its regulations to use an unregistered pesticide or to use a product in a way that is inconsistent with the directions or limitations as shown on the product label.

**Plant Protection Act**

Administered by Agriculture and Agri-Food Canada, this Act is to protect plant life and the agriculture and forestry industries by preventing the importation, exportation, and spread of injurious pests.

**Species At Risk Act**

The purpose of this Act is to prevent native species in Canada from becoming extirpated or extinct, to provide for the recovery of endangered or threatened species and to manage species of special concern to prevent them from becoming endangered or threatened. Once a species is legally listed, the Act requires that recovery strategies be developed for extirpated, endangered and threatened species, and that action plans be developed where recovery is feasible.

- Schedule 1 of the Act sets out the legal list of species at risk (extirpated, endangered, threatened and special concern) in Canada.
Where the Act applies, it makes it illegal to kill, harm, harass, capture or take a species at risk, or to possess, collect, buy, sell or trade any individual or parts of an individual that is at risk. The Act also prohibits the damage or destruction of either the residence (for example, the nest or den) or the critical habitat of any species at risk. Critical habitat is legally identified in a posted recovery strategy or action plan.

While the Act applies to all land and waters in Canada, these prohibitions only apply to areas of federal jurisdiction including migratory birds, all waters (sea and fresh) in Canada, as well as to all federal lands, including Indian reserves and national parks, and the airspace above them.

On private land, the SARA prohibitions apply only to:
- aquatic species at risk; and
- migratory birds listed in the *Migratory Birds Convention Act, 1994* and also listed as endangered, threatened or extirpated in Schedule 1 of the Act

The provisions of the *Species at Risk Act* (known as the ‘safety net’) could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

Note that SARA prohibitions do not apply to species of special concern, and that species at risk in Canada may also be protected by provincial or territorial laws.

More information about how the Act applies on private land can be found on the *Species at Risk Act* public registry at: [http://www.sararegistry.gc.ca/involved/you/privland_e.cfm](http://www.sararegistry.gc.ca/involved/you/privland_e.cfm)

**Transportation of Dangerous Goods Act, 1992**

Under this Act, Transport Canada is responsible for regulating the handling and transportation of poisonous substances, flammable and combustible liquids and other products hazardous to the environment. The Act has been adopted as provincial legislation and is administered by the BC Ministry of Transportation and Infrastructure.

Certain dangerous goods cannot be transported unless requirements are met about shipping documents, special product labels, vehicle placards and safety procedures. Training in special safety procedures and certification of individuals may also be required.

Dangerous goods may include pesticides. Transportation of large quantities (more than 500 kg) of pesticides requires shipping documents, special product labels and vehicle placards.

**Wildlife Act**

Administered by the Canadian Wildlife Service, this Act makes provision for Environment Canada to work by itself or in cooperation with others to acquire lands for the research, conservation and interpretation of migratory birds. Wildlife areas established under this Act are called National Wildlife Areas.
A.4 ENFORCEMENT BY REGULATORY AGENCIES

Municipal Enforcement of Local Bylaws
Enforcement varies with each local government. Under the Local Government Act, local government has the ability to enforce bylaws through a fine, imprisonment, or both.

Local government can authorize officers, employees and agents of a municipality to enter on a property to ascertain whether a requirement is being met or regulations are being observed. They may also authorize the use of ticketing by a bylaw enforcement officer.

Provincial Enforcement of the Environmental Management Act
Note that Provincial Acts and Regulations make no provisions for “nonconforming status”, as does local government legislation.

Code of Agricultural Practice for Waste Management. How does the Code under the Agricultural Waste Control Regulation apply? Compliance with the Code provides producers exemption from requiring a permit to discharge agricultural waste as a fertilizer or soil amendment. Where you do not comply with the Code, you are subject to the Environmental Management Act and must have a permit. If you do not have a permit, you can be charged for “introducing business wastes into the environment without authorization.” Where a charge indicates “pollution” has occurred, it means “presence in the environment of substances or contaminates that substantially alter or impair the usefulness of the environment”

Work “In and About a Stream” under the Provincial Water Act
Any work ‘in and about a stream’ requires approval from provincial and federal agencies. A detailed publication from the Ministry of Environment, “Standards and Best Practices for Instream Works”, is available at the following web site:

Federal Enforcement of the Fisheries Act
This is federal legislation specifically designed to protect fish and fish habitat. Fish habitat includes spawning grounds and nursery, rearing, food supply and migration areas on which the fish depend directly or indirectly. Fish do not need to actually physically use an area or be in the area to have the area defined as habitat. Similarly, if they only use it for a small part of the year, it is habitat. Habitat includes the riparian vegetation. In other words, if it influences the life of fish it is protected.

Fish habitat may be created on a farm when a farm project is completed; for instance, when a drainage ditch is dug that empties into a stream and is accessible or used by fish. The ditch is considered an extension of the stream and the Fisheries Act provisions will apply.

Primary sections of this Act that producers need to be aware of are:
♦ harmful alteration, disruption and destruction of fish habitat
♦ introduction of a deleterious substance affecting either fish or fish habitat
  ♦ this could also be pollution and fall under the provincial Environmental Management Act - in such cases where pollution impacts fish or fish habitat, charges may be pursued under both acts; MOE and Fisheries and Oceans Canada may jointly or independently investigate
♦ proper screening of water intakes
♦ destruction of fish by means other than fishing
♦ allowing safe passage of fish
♦ minimum stream flows for fish
**Fisheries and Oceans Canada Authorizations.** When planning work “in and about a stream” (any water body) it is the landowner’s responsibility to ensure that the work or activity does not cause a harmful alteration, disruption or destruction of fish habitat, except where authorized by the Minister or his designate. It is also the landowner’s responsibility to ensure that there is no deposit of any deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance may enter such waters.

The types of activities that typically require Fisheries and Oceans Canada authorization include; rip rap; riparian alteration (such as removing streamside vegetation); channel alteration (straightening, redirecting, side channel filing, wetland draining); dredging; ditch cleaning; construction close to streams or lakes (fill, retaining walls, docks, bridges, diking); driving through streams (fording).

Authorization can be obtained by contacting Fisheries and Oceans Canada (DFO) directly. Arrangements and procedures are in place with some provincial agencies, Municipalities, or in some cases, producer groups, to assist in identifying situations requiring authorization.

Where a charge indicates “introduction of a deleterious substance” has occurred it means:

♦ a substance when added to any water degrades or alters or forms part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water

Unlike provincial legislation that refers to “pollution”, the federal Fisheries Act refers to depositing and placing a deleterious substance, not only the resulting impact that may occur to the environment.

A publication from the Fisheries and Oceans Canada (DFO), “Complying with the Fisheries Act” (containing extracts from the *Fisheries Act* relating to the habitat protection and pollution prevention provisions), is available at the following web site


**A.5 INFORMATION FOR LANDOWNERS**

It is important to get a basic understanding of the “rules”, such as the main Acts, as well as your “rights and responsibilities.” AGRI publications, your producer associations, and the enforcement web sites above can be a start.

Use beneficial management practices and review operations on your farm to identify potential sources of pollution. This may be achieved by completing an Environmental Farm Plan. Do your best to schedule and budget improvements to bring your operation into compliance with the Code under the Agricultural Waste Control Regulation before a complaint is filed. Check with AGRI to see if programs might be available to help reduce costs or provide expertise to help resolve concerns. In this manner, improvements are made on your terms, as your time and resources are available.

If an enforcement officer informs you of an issue, be polite and find out what the issue or problem is. Try to keep an open mind in order to get to the root of the issue. Try to identify and accept the problem then try to think of changes in management or practices would alleviate the concern. In many cases, relatively minor changes can improve or eliminate the problem.

Take notes, keep track of what occurs when talking to an enforcement officer and focus your attention on a solution. Consider first cooperating fully to get the problem under control, and then, if necessary, dealing with the issue of blame, or who caused the problem. While it is reasonable for you to cooperate, you do not have to incriminate yourself. At some point if you are uncomfortable or do not understand the situation in entirety, you may want to seek advice from your industry association or a lawyer.
Influencing Factors in a Prosecution. Five main factors can influence the prosecution of a case. You have some control over the first four of these:

1. **Your Due Diligence** - the need to foresee and prevent a problem before it occurs as well as your reaction to a problem:
   - due diligence is defined in the dictionary as “constant and earnest effort”
   - due diligence is the action that would be expected, and ordinarily exercised by, a reasonable and prudent professional or expert in the field under the circumstances; *it may not be just the knowledge and skill of an ordinary person*; put another way, an accused must take all reasonable steps to prevent the an infraction, however, this does not mean the accused must take all conceivable steps
   - due diligence is not something measured by an absolute standard but depends on the facts of each case
   - you may want to seek assistance or advice to ensure you are in fact exercising ‘due diligence’

   The standard of due diligence will be applied to your actions, or lack of actions, prior to, during and after a problem. Should an *Order* be issued, your due diligence may prevent a *Charge* from occurring, depending on the circumstances. As mentioned previously, something as simple as good communication with MOE will help.

   A prosecution is likely to occur in circumstances where the problem occurred as a result of carelessness. On the other hand, if the investigation determined that you did everything that could be reasonably expected under the circumstances (i.e., you exercised all due diligence) and the problem still occurred, then this may be considered by officers and the Court should your case proceed to court.

   The only defense against an infraction is to demonstrate you have followed due diligence. It is important to note that the Crown doesn’t have to prove the lack of due diligence; the onus is on you to prove you exercised due diligence.

2. **Mitigative, Corrective, or Restorative Actions You’ve Taken to Minimize the Impact** – this is related to due diligence:
   - how you deal with a problem that has been pointed out to you may be recognized in any judgment

3. **Your Compliance History** - how you’re handled any similar past situations may have a bearing on whether an agency places any trust in you to handle current concerns.

4. **Severity of the Impact** – this concerns the problem itself:
   - the more severe the problem the more likely prosecution may proceed
   - you may have control of the problem through management practices
   - prior due diligence may not only reduce the severity of any potential problem but may also serve you well in the face of legal action

5. **Sensitivity of the Receiving Environment** - this is beyond your control:
   - while the *Code* under the *Agricultural Waste Control Regulation* and other legislation is in place for all of BC, enforcement may be ‘heightened’ in the more sensitive environments
   - if you are located near such environments you will need to be diligent

The Role of an Environmental Farm Plan

Having an Environmental Farm Plan can be a very good step in demonstrating due diligence:

- use the Environmental Farm Plan Workbook
- implement the resulting Action Plan using appropriate Beneficial Management Practices

[BC Environmental Farm Plan: Reference Guide](#)
[BC Environmental Farm Plan: Planning Workbook](#)
A.6 AGRICULTURAL WASTE CONTROL REGULATION & CODE OF AGRICULTURAL PRACTICE FOR WASTE MANAGEMENT

The provincial Environmental Management Act has an Agricultural Waste Control Regulation. This Regulation provides that ‘agricultural operations’ (which are defined) that are carried out in accordance with the Code of Agricultural Practice for Waste Management are exempt from sections 6(2) and (3) of the Act that require a permit to discharge ‘agricultural waste’ (which is defined) into the environment.

The Code does not exempt agricultural operations from any other part of the Environmental Management Act. Also, note the Code deals only with wastes and pollution not with other environmental concerns (such as habitat).

This regulation was originally brought into force in 1992 under the then Waste Management Act. That Act has been changed and is now the Environmental Management Act. The following copy of the Act is only for reference and is not an official version. Visit www.bclaws.ca for the current version of the regulation.

**Agricultural Waste Control Regulation**
[includes amendments up to B.C. Reg. 377/2008, December 9, 2008]
Code of Agricultural Practice for Waste Management, April 1, 1992

**Interpretation**
1 In this regulation:
   "agricultural operation" means any agricultural operation or activity carried out on a farm including
   (a) an operation or activity devoted to the production or keeping of livestock, poultry, farmed game, fur bearing animals, crops, grain, vegetables, milk, eggs, honey, mushrooms, horticultural products, tree fruits, berries, and
   (b) the operation of machinery and equipment for agricultural waste management or application of fertilizers and soil conditioners;

   "Code" means the Code of Agricultural Practice for Waste Management April 1, 1992 attached to this regulation.

**Exemptions**
2 (1) Subject to subsections (2) and (3), a person who carries out an agricultural operation in accordance with the Code is, for the purposes of carrying out that agricultural operation, exempt from section 6 (2) and (3) of the Environmental Management Act.

   (2) A person who, on the date this subsection came into force, was carrying out an agricultural operation in which a boiler or heater was used is, for the purposes of carrying out that agricultural operation, exempt from section 6 (2) and (3) of the Environmental Management Act only if, in addition to complying with the Code, that person registers in accordance with subsection (4) before May 1, 2009.

   (3) A person, other than one referred to in subsection (2), who carries out an agricultural operation in which a boiler or heater is used is, for the purposes of carrying out that agricultural operation, exempt from section 6 (2) and (3) of the Environmental Management Act only if, in addition to complying with the Code, that person has registered in accordance with subsection (4) before the boiler or heater is used.

   (4) To register for the purposes of subsection (2) or (3), the person carrying out the agricultural operation must complete the form and comply with the procedures specified by a director.
(5) A person registered under subsection (4) must notify a director of any change in the information provided in the person's registration.

Code of Agricultural Practice for Waste Management, April 1, 1992

PART 1 — PURPOSE

Purpose
1 The purpose of this Code is to describe practices for using, storing and managing agricultural waste that will result in agricultural waste being handled in an environmentally sound manner.

PART 2 — INTERPRETATION

Interpretation
2 (1) In this Code:
"agricultural unit" means a live weight of 455 kg (1 000 lbs) of livestock, poultry or farmed game or any combination of them that equals 455 kg;
"agricultural waste" includes manure, used mushroom medium and agricultural vegetation waste;
"biogas" means a gas derived from the anaerobic decomposition of organic matter;
"biomass" means
(a) agricultural fuel products, including agricultural pellets, manure pellets, corn kernels, corn stalks and seed hulls, or
(b) wood or wood products,
but does not include
(c) any raw manure,
(d) any paper or paper product,
(e) any wood or wood product that has been treated with glue, paint or preservative or that contains a foreign substance harmful to humans, animals or plants when combusted, or
(f) any salt-laden wood or wood product with a chloride content exceeding 0.05% on a dry basis;
"capacity", in relation to a boiler or heater, means the maximum rate of energy output from the boiler or heater measured in megawatts of thermal energy;
"confined livestock area" means an outdoor, non-grazing area where livestock, poultry or farmed game is confined by fences, other structures or topography including feedlots, paddocks, corrals, exercise yards and holding areas, but not including a seasonal feeding area;
"farmed game" means any animal held under the authority of a licence under the Game Farm Act;
"feedlot" means a fenced area where livestock, poultry or farmed game is confined solely for the purpose of growing or finishing and is sustained by means other than grazing;
"field storage" means a temporary stock of agricultural waste ready to be drawn upon for use as a crop fertilizer or soil conditioner;
"grazing area" means a pasture or rangeland where livestock, poultry or farmed game is primarily sustained by direct consumption of feed growing on the area;
"groundwater" means water below the surface of the ground;
"heating season" means a period beginning on October 1 in one year and ending on April 30 in the next year;
"landfill gas" means a mixture of gases generated by the decomposition of municipal solid waste;
"low-sulphur fuel" means
(a) No. 2 heating oil, or
(b) diesel fuel for use in Canada in on-road vehicles;

"manufactured wood fuel" means wood pellets and wood pucks;

"mortalities" means livestock, poultry or farmed game that has died and that is unmarketable;

"municipal solid waste" has the same meaning as in Part 3 of the Environmental Management Act;

"mushroom medium" means a mixture that is composted and used as a medium for growing mushrooms;

"particulate matter" means total filterable particulate matter;

"pollution" means the presence in the environment of substances or contaminants that substantially alter or impair the usefulness of the environment;

"precipitation" means precipitation as determined by the Canadian Atmospheric Environmental Service Reports of Environment Canada;

"seasonal feeding area" means an area
(a) used for forage or other crop production, and
(b) used seasonally for feeding livestock, poultry or farmed game that is primarily sustained by supplemental feed,
but does not include a confined livestock area or grazing area;

"soilless medium" means a material that is manufactured for the growing of plants and may contain natural soils;

"solid agricultural waste" means agricultural waste that
(a) is 20% or more solid matter, and
(b) will not flow when piled;

"storage facility" includes a structure, reservoir, lagoon, cistern, gutter, tank or bermed area for containing agricultural waste prior to its use or disposal, but does not include a vehicle or any mobile equipment used for transportation or disposal of agricultural waste;

"watercourse" means a place that perennially or intermittently contains surface water, including a lake, river, creek, canal, spring, ravine, swamp, salt water marsh or bog, and including a drainage ditch leading into any of the foregoing;

"wood product" includes manufactured wood fuel, hog fuel, mill ends, wood chips, bark, shavings, sawdust and firewood;

"wood waste" includes hog fuel, mill ends, wood chips, bark and sawdust, but does not include demolition waste, construction waste, tree stumps, branches, logs or log ends.

PART 3 — GENERAL

General
3 Agricultural wastes, wood waste and mortalities must be collected, stored, handled, used and disposed of in accordance with this Code and in a manner that prevents pollution.

PART 4 — STORAGE AND USE OF AGRICULTURAL WASTE

Allowable storage
4 Agricultural waste may be stored on a farm only if the waste is produced or used on that farm.

Storage methods
5 When agricultural waste is stored, it must be stored
(a) in a storage facility,
(b) as field storage, or
(c) in the case of waste from fur bearing animals, under their outdoor pens.
Storage facility
6 A storage facility must
(a) be of sufficient capacity to store all the agricultural waste produced or used on
the farm for the period of time needed to allow for
   (i) the application of agricultural waste as a fertilizer or soil conditioner,
   or
   (ii) the removal of agricultural waste,
(b) prevent the escape of any agricultural waste that causes pollution, and
(c) be maintained in a manner to prevent pollution.

Location of storage facility
7 (1) A storage facility must be located at least 15 m from any watercourse and 30 m from any
source of water for domestic purposes.
(2) Subsection (1) does not apply to a storage facility existing prior to April 1, 1992 provided
that a report
(a) demonstrating to the satisfaction of a director that no pollution of any
watercourse or domestic water supply is occurring from the storage facility, and
(b) produced by
   (i) a person with professional qualifications in the field of environmental
assessment and licensed to practice in British Columbia, or
   (ii) staff of the ministry of the minister charged with the administration of
the Farm Practices Protection (Right to Farm) Act under a Best
Agricultural Waste Management Plan
is made available to the director within 12 months of his or her request.

Field storage
8 (1) Solid agricultural waste may be stored on a field for 2 weeks or less if the agricultural waste is
(a) used within 2 weeks, and
(b) stored in a manner that prevents the escape of agricultural waste that causes
pollution.
(2) Solid agricultural waste may be stored on a field for more than 2 weeks if the agricultural
waste is
   (a) stored for no longer than 9 months,
   (b) located at least 30 m from any watercourse or any source of water used for
domestic purposes, and
   (c) stored in a manner that prevents the escape of agricultural waste that causes
pollution.
(3) Berms or other works must be constructed around a field storage area if this is necessary to
prevent the escape of agricultural waste that causes pollution.

Rainy season field storage
9 In areas of the Province, including the Fraser Valley and Vancouver Island, that receive a total
average precipitation greater than 600 mm (24 in) during the months of October to April
inclusive, field stored solid agricultural wastes, except agricultural vegetation waste, must be
covered from October 1 to April 1 inclusive to prevent the escape of agricultural waste that
causes pollution.

Under pen storage
10 (1) Agricultural waste from fur bearing animals may be stored under their outdoor pens for up to
9 months if the storage area under the pens
   (a) prevents the escape of any agricultural wastes that causes pollution, and
   (b) is located at least 15 m from a watercourse and 30 m from any source of water
used for domestic purposes.
(2) Subsection (1) (b) does not apply to a pen constructed prior to April 1, 1992 provided that a report
(a) demonstrating to the satisfaction of a director that no pollution of any watercourse or domestic water supply is occurring from the under pen storage facility, and
(b) produced by
(i) a person with professional qualifications in the field of environmental assessment and licensed to practice in British Columbia, or
(ii) staff of the ministry of the minister charged with the administration of the Farm Practices Protection (Right to Farm) Act under a Best Agricultural Waste Management Plan
is made available to the director within 12 months of his or her request.

PART 5 — APPLICATION AND COMPOSTING OF AGRICULTURAL WASTE

Discharge to water
11 Agricultural waste must not be directly discharged into a watercourse or groundwater.

Allowable application
12 Agricultural waste must be applied to land only as a fertilizer or a soil conditioner.

Prohibited application
13 Agricultural waste must not be applied to the land if, due to meteorological, topographical or soil conditions or the rate of application, runoff or the escape of agricultural waste causes pollution of a watercourse or groundwater.

Conditions unfavorable to application
14 Agricultural wastes must not be applied
(a) on frozen land,
(b) in diverting winds,
(c) on areas having standing water,
(d) on saturated soils, or
(e) at rates of application that exceed the amount required for crop growth, if runoff or escape of agricultural waste causes pollution of a watercourse or groundwater, or goes beyond the farm boundary.

Composting
15 Agricultural waste may be composted on a farm if
(a) the agricultural waste being composted consists only of agricultural waste
   (i) produced on that farm, or
   (ii) produced elsewhere but being composted for use on that farm only,
(b) the composting site is located at least 15 m from a watercourse and 30 m from any source of water used for domestic purposes, and
(c) the agricultural waste is composted in a manner that does not cause pollution.

Composting for mushroom medium
16 (1) Composting agricultural waste for the production of mushroom medium on a farm is allowed if
(a) the mushroom medium produced is used only on that farm,
(b) the composting site is located at least 15 m from a watercourse and 30 m from any source of water used for domestic purposes, and
(c) the medium is composted in a manner that does not cause pollution.
(2) Subsection (1) (a) and (b) does not apply to a composting operation and site existing prior to April 1, 1992 provided that a report
(a) demonstrating to the satisfaction of a director that no pollution of any watercourse or domestic water supply is occurring from the composting operation and site, and
(b) produced by
   (i) a person with professional qualifications in the field of environmental assessment and licensed to practice in British Columbia, or
   (ii) staff of the ministry of the minister charged with the administration of the Farm Practices Protection (Right to Farm) Act under a Best Agricultural Waste Management Plan

is completed by April 1, 1993 and is made available to the director at his or her request.

PART 6 — AGRICULTURAL EMISSIONS

Emissions
17 Emissions from forced air ventilation systems used on a farm must not cause pollution.

Restrictions relating to types of boiler and heater fuel
18 Only the following fuels may be used in an agricultural operation as fuel for a boiler or heater:
   (a) biomass;
   (b) natural gas;
   (c) propane;
   (d) low-sulphur fuel;
   (e) biogas;
   (f) landfill gas.

Emission standards for boilers and heaters fuelled by biomass
18.1 (1) This section applies to a boiler or heater that
   (a) is fuelled by biomass, and
   (b) is used in an agricultural operation.

   Subject to subsections (3) and (4), emissions from a boiler or heater referred to in subsection (1) that has a capacity specified in any of items 1 to 3 of column 1 of Table 1 must not exceed the following standards:
   (a) effective on the date this section comes into force, the particulate matter limit and the opacity limit specified in column 2 opposite that item;
   (b) effective on May 1, 2009, the particulate matter limit and the opacity limit specified in column 3 opposite that item;
   (c) effective on September 1, 2010, the particulate matter limit and the opacity limit specified in column 4 opposite that item.

   (3) For the purpose of subsection (2), particulate matter must be determined under standard conditions of 20° Celsius, 101.3 kPa dry gas and 8% oxygen.

   (4) Subsection (2) does not apply to emissions from a boiler or heater during the 60 minutes after it is started.

   (5) The person carrying out the agricultural operation must comply with any minimum stack discharge height set under subsection (6).

   (6) A director may set a minimum stack discharge height for a boiler or heater referred to in subsection (1).
Testing of certain boilers and heaters fuelled by biomass

18.2 (1) This section applies to a boiler or heater that
(a) is fuelled by biomass,
(b) is used in an agricultural operation, and
(c) has a capacity exceeding one megawatt.

(2) For the purpose of ensuring compliance with section 18.1, the person carrying out the agricultural operation must have emissions from a boiler or heater referred to in subsection (1) tested in accordance with this section.

(3) Emissions from the boiler or heater must be tested for particulate matter
(a) within 6 months
   (i) after the installation of the boiler or heater, and
   (ii) after the modification of the boiler or heater to increase its capacity by 25% or more,
(b) at the intervals specified in subsection (5) or (6), as applicable, and
(c) at any time required by a director under section 18.3.

(4) If the boiler or heater did not have a capacity exceeding one megawatt on the date of installation, emissions from the boiler or heater must be tested for particulate matter
(a) within 6 months
   (i) after the modification of the boiler or heater to increase its capacity to exceeding one megawatt, and
   (ii) after any further modification of the boiler or heater to increase its capacity by 25% or more,
(b) at the intervals specified in subsection (5) or (6), as applicable, and
(c) at any time required by a director under section 18.3.

(5) Subject to subsection (6), emissions from the boiler or heater must be tested for particulate matter not less than once during each heating season after September 1, 2009.

(6) If the boiler or heater has a capacity not exceeding 3 megawatts and is fuelled exclusively by manufactured wood fuel, emissions from the boiler or heater must be tested for particulate matter not less than
(a) once during the heating season beginning on October 1, 2009, and
(b) once during every second heating season after the heating season referred to in paragraph (a).

(7) Emissions from the boiler or heater must be tested under normal operating conditions and when the boiler or heater is operating at not less than 75% of its capacity and is fuelled only by biomass.

(8) All testing must be carried out using the methodology specified by a director.
If the testing data indicate that emissions from the boiler or heater exceed the applicable particulate matter limit specified in Table 1, the person carrying out the agricultural operation must

(a) immediately notify the manager for the region in which the agricultural operation is carried out,
(b) take corrective action within 30 days after notifying that manager, and
(c) have emissions from the boiler or heater tested for particulate matter
   (i) within 6 months after corrective action has been taken, and
   (ii) not less than
       (A) once in the next heating season, or
       (B) if the boiler or heater has a capacity not exceeding 3 megawatts and is fuelled exclusively by manufactured wood fuel, once in the next heating season and then once in every second heating season.

Additional testing and monitoring of boilers and heaters
18.3 A director may require the person carrying out an agricultural operation to
(a) have additional testing or monitoring done in respect of emissions from a boiler or heater to which section 18.2 applies, or
(b) have any other boiler or heater used in the agricultural operation tested or monitored.

Record keeping requirements for boilers and heaters fuelled by biomass
18.4 (1) This section applies to a boiler or heater fuelled by biomass that is used in an agricultural operation.
(2) The person carrying out the agricultural operation must keep accurate records and supporting documentation in respect of
(a) all inspections and the maintenance of the boiler or heater,
(b) the type, source and quantity of fuel burned by the boiler or heater, and
(c) the results of testing or monitoring required under section 18.2 or 18.3.

Authority to require that other records be kept
18.5 A director may require the person carrying out an agricultural operation to keep any of the following:
(a) in relation to a boiler or heater that is fuelled otherwise than by biomass and is used in the agricultural operation, accurate records and supporting documentation in respect of
   (i) all inspections and the maintenance of the boiler or heater,
   (ii) the type, source and quantity of fuel burned by the boiler or heater, and
   (iii) the results of testing or monitoring required under section 18.3 (b);
(b) in relation to any boiler or heater used in the agricultural operation, accurate records and supporting documentation that are additional to those required under paragraph (a) or section 18.4.

Retention and submission of records
18.6 A person required under section 18.4 or 18.5 to keep a record and supporting documentation must
(a) retain the record and supporting documentation for not less than 3 years after the date on which the record was made, and
(b) submit the record and supporting documentation to a director or an officer within 5 business days of being requested by the director or officer to do so.
Odours not prohibited
19 Nothing in this Code is intended to prohibit various odours from agricultural operations or activities on a farm, providing such operations or activities are carried out in accordance with this Code.

PART 7 — STORAGE AND USE OF WOOD WASTE

Allowable use
20 Wood waste may only be used for
(a) plant mulch, soil conditioner, ground cover, on-farm access ways, livestock bedding and areas where livestock, poultry or farmed game are confined or exercised,
(b) berms for cranberry production, or
(c) fuel for wood fired boilers.

Storage
21 Wood waste stored and used on a farm must be handled so as to prevent any escape of
(a) particulate or solid matter from the wood waste into the air, or
(b) particulate or solid matter or leachate from the wood waste into any watercourse or groundwater
that causes pollution.

Prohibited use
22 Wood waste used on the farm must not be used
(a) for landfill, and
(b) on sites within 30 m of any source of water used for domestic purposes with the exception of existing sites under use prior to April 1, 1992, provided that this use is not causing pollution.

PART 8 — ON-FARM DISPOSAL OF MORTALITIES

Burial and incineration
23 (1) Mortalities may be disposed of on-farm by burial or incineration if
(a) the mortalities are livestock, poultry or farmed game disposed of on the farm where they died,
(b) the disposal does not cause pollution,
(c) where disposal is to land, the burial pits are covered, located at least 30 m from any source of water used for domestic purposes and constructed to prevent the escape of any agricultural waste that causes pollution, and
(d) where disposal is by incineration, the emissions from an incinerator do not exceed 180 mg per cubic metre of particulate matter and 20% opacity, except that
(i) for a permanent incinerator installed before April 1, 1992 and not operating under a waste management permit, emissions must not exceed 230 mg per cubic metre of particulate matter and 20% opacity, and
(ii) for a permanent incinerator installed before April 1, 1992 and operating under a waste management permit, the emission levels required by that permit apply unless those levels exceed the levels specified in (i).

Composting
24 Mortalities may be composted on-farm if
(a) the mortalities are composted on the farm where they died,
(b) the composting site is located at least 15 m from a watercourse and 30 m from any source of water used for domestic purposes, and
(c) the composting does not cause pollution.
PART 9 — FEEDING AREAS AND ACCESS TO WATER

Grazing areas
25 Livestock, poultry or farmed game feeding within a grazing area may have access to watercourses, provided that the agricultural waste produced by that livestock, poultry or farmed game does not cause pollution.

Seasonal feeding areas
26 (1) A seasonal feeding area for livestock, poultry or farmed game must
   (a) be operated in a way that does not cause pollution, and
   (b) have berms where necessary to prevent agricultural waste runoff from causing pollution.
(2) Locations for feeding livestock, poultry or farmed game within a seasonal feeding area, including locations for movable feed bunks, must
   (a) be at least 30 m from a high tide watermark, a watercourse or the bank of a watercourse, unless written permission has been obtained from a director for a closer location, and
   (b) be distributed throughout the area to ensure that manure from the feeding of livestock, poultry or farmed game is spread as a fertilizer or soil conditioner and that no accumulation of manure causes pollution.
(3) Where permanent feed bunks are used within a seasonal feeding area, written permission for the location of the bunks must be obtained from a director.

Seasonal area access
27 Livestock, poultry or farmed game in a seasonal feeding area may have access to watercourses provided that
   (a) the feeding of livestock, poultry or farmed game is in accordance with section 26, and
   (b) the access is located and maintained as necessary to prevent pollution.

Confined area access
28 Livestock, poultry or farmed game in a confined livestock area may not have access to a watercourse, with the exception of a holding area on rangeland where
   (a) livestock is held no longer than 72 hours,
   (b) the watercourse is not a source of water used for domestic purposes at any location downstream from the confined livestock area, and
   (c) the access is located and maintained as necessary to prevent pollution.

Confined area operation
29 (1) Confined livestock areas must be operated in a way that does not cause pollution.
(2) If there are more than 10 agricultural units in a confined livestock area or areas within the same drainage basin then the area or areas must be located at least 30 m from a high tide watermark, a watercourse, the bank of a watercourse or any source of water used for domestic purposes.
(3) Subsection (2) does not apply to a permanent confined livestock area constructed prior to April 1, 1992 provided that a report
   (a) demonstrating to the satisfaction of a director that no pollution of any watercourse or domestic water supply is occurring from the permanent confined livestock area, and
   (b) produced by
      (i) a person with professional qualifications in the field of environmental assessment and licensed to practice in British Columbia, or
(ii) staff of the ministry of the minister charged with the administration of the *Farm Practices Protection (Right to Farm) Act* under a Best Agricultural Waste Management Plan is completed by April 1, 1993 and is made available to the director at his or her request.

**PART 10 — USE AND STORAGE OF AGRICULTURAL PRODUCTS**

**Agricultural products**

30 Agricultural products such as livestock, poultry, farmed game, fur bearing animals, animal and poultry feeds, forage silage, forage crops, vegetables and chemical fertilizers must be managed, used and stored in a manner that prevents the escape of agricultural waste that causes pollution.

**Mushroom or soilless medium**

31 Raw materials for making products such as mushroom medium or soilless medium must be used and stored in a manner that prevents the escape of agricultural waste that causes pollution.
Appendix B  Contents

B.1 Precipitation .............................................................................. B-2
B.2 Peak Irrigation Flow Requirements .......................................... B-4
B.3 Annual Crop Water Requirements ............................................. B-6
The climate of British Columbia can be divided into 4 broad climatic regions. Within these regions there are a variety of microclimates that also affect farm planning.

The Pacific Coast (Lower Mainland and Vancouver Island) experience warm summers and wet winters. In this area climate affects the spreading and storage requirements for manure. Drainage and stormwater are also important issues for farms.

The Southern BC climate encompasses the Cariboo, Kootenays and Okanagan. Summers are warm and dry with frequent hot days, while winters are cold – precipitation is variable over this area. The temperature and precipitation vary from the north to south of the region and from the lower to higher elevations within the valleys. This area contains some of the driest areas in BC. The climate mainly affects irrigation and other water use.

The north east part of the province (Peace River area) has a prairie climate. The region is under the influence of cold dry arctic air. The area has short cool summers while winters are typically long with persistent snow cover although precipitation is light. In this area the climate mainly affects manure spreading and storage. Water availability and efficient use of resources is also an issue.

The North BC Mountains is mainly alpine and sub-alpine with long cold winters and short cool summers. Agriculture is limited in this area.
B.1 PRECIPITATION

The map in Figure B.1 shows the areas of the province which receive a total average precipitation greater than 600 mm during the months of October 1\textsuperscript{st} to April 30\textsuperscript{th} inclusive (high precipitation). It also suggests manure storage capacity for different areas.

Table B.1 shows the highest total 25-year precipitation that should be designed for when sizing manure storage facilities and predicting runoff volumes. Operation not near one of the locations listed can estimate the highest total 25-year precipitation by multiplying the average precipitation (over the appropriate storage period) by 1.5.
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1 Locations:  A = Airport  CDA = Agricultural -Agri Food Canada  STP = Sewage Treatment Plant
2 6 months (180 days) are October to March inclusive, 7 months (210 days) are October to April inclusive.
3 Highest total precipitation over the past 25 years of records for the storage period indicated. To convert metres to millimeters, multiply the precipitation number by 1,000.
4 For sites with less than 25 years of weather data the number in ( ) indicates the years of records.

For locations not listed, use an approximation of 1.5 x the average precipitation.
Equation 19, page 208, uses these precipitations to calculate the runoff to be stored from various surfaces.
B.2 PEAK IRRIGATION FLOW REQUIREMENTS

The map in Figure B.2 gives a general overview of flow rates in BC. If you are near one of the locations listed in Table B.2 use the flow rate from the table in your calculation, or use the flow rate given on the farm’s irrigation water licence. Water provided by a water purveyor may already have a preset flowrate.

The flow rates provided here are for general guidance. The elevation of the farm also affects flow rate requirements. Farms at valley bottoms have higher flow rates than farms in the same area at a higher elevation.

Figure B.2 Estimated Peak Irrigation Flow Requirements in BC
US gallons per minute per acre (gpm/acre)
### Table B.2 Estimated Peak Irrigation Flow Rate Requirements for Various BC Locations\(^1\), \(^2\)

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<td>Lillooet</td>
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\(^1\) Values based on a 10% risk (may be short of water 1 in 10 years)
\(^2\) Based on evapotranspiration values and on average deep-rooted crop in a medium textured soil
\(^3\) Multiply the values in US gpm /acre by 0.156 to convert to L/s /ha
B.3 ANNUAL CROP WATER REQUIREMENTS

The map in Figure B.3 gives a general overview of annual crop water requirements in BC. If you are near one of the locations listed in Table B.3 use the annual water requirement from the table in your calculation.

An area with a high peak flow rate will not necessarily mean a high annual irrigation requirement. High summer temperatures mean a high peak flow rate. However, if the irrigation season is short the annual water requirement will be lower than an area with a longer irrigation season. For example: Terrace and Kelowna have the same peak flow rate, but Kelowna has a much longer growing season and therefore a larger annual crop water requirement.
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<th>Depth per Area</th>
<th>Location</th>
<th>Depth per Area</th>
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1 Based on evapotranspiration values and on average deep-rooted crop in a medium textured soil
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C

PUBLICATIONS & WEBSITES

C.1 PUBLICATIONS

The following publications are referenced in this Guide for further details on environmentally related subjects.

SAM # is the publication number of the Sustainable Agriculture Management Branch, AGRI publications. SAM publications are available on the web at: www.agf.gov.bc.ca/resmgmt/publist/Publ_List_Home.htm.

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<td>An Overview of On-Farm Biogas Production</td>
<td>2008</td>
<td>AGRI</td>
<td>382.600-1</td>
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<td>B.C. Agricultural Composting Handbook (series of Facts</td>
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<td>B.C. Agricultural Fencing Handbook (series of Factshe</td>
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<td>B.C. Agriculture Drainage Manual</td>
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<td>AGRI</td>
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<td>B.C. Grasslands Stewardship Guide</td>
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<td>B.C. Greenhouse Gas Inventory Report 2007</td>
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<td>B.C. Landscape Standard</td>
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<td>BC Landscape and Nursery Association</td>
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<td>B.C. Livestock Watering Handbook (series of Factsheets)</td>
<td>2006</td>
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<td>B.C. Irrigation Management Guide</td>
<td>2005</td>
<td>Irrigation Industry Association of BC</td>
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<td>B.C. Sprinkler Irrigation Manual</td>
<td>1998</td>
<td>Irrigation Industry Association of BC</td>
<td>552.000-1</td>
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<td>B.C. Trickle Irrigation Manual</td>
<td>1999</td>
<td>Irrigation Industry Association of BC</td>
<td>565.000-1</td>
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<td>Beaver Damage Control in Agricultural Areas of B.C.</td>
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<td>Biodiversity and Riparian Areas - life in the green zone</td>
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<td><a href="http://www.cowsandfish.org">www.cowsandfish.org</a></td>
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<td>Bird Predation Management Plan - Blueberries</td>
<td>2009</td>
<td>AGRI</td>
<td>670.300-1</td>
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<tr>
<td>Blue-Green Algal Blooms in Lakes</td>
<td>1994</td>
<td>MOE</td>
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<td>Bridge Construction (constructed ditches)</td>
<td>2005</td>
<td>AGRI / DFO</td>
<td>373.020-1</td>
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<td>British Columbia Approved Water Quality Guidelines</td>
<td>2006</td>
<td>MOE</td>
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<td>British Columbia Game Farm Manual</td>
<td>1997</td>
<td>AGRI</td>
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<td>Building an Environmentally Sound Outdoor Riding Ring</td>
<td>2005</td>
<td>AGRI</td>
<td>386.000-7</td>
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<td>Calibration Worksheet - Boom Sprayer</td>
<td>1998</td>
<td>AGRI</td>
<td>234.005-2</td>
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<tr>
<td>Canadian Farm Buildings Handbook</td>
<td>1988</td>
<td>AAFC</td>
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<td>Canadian Water Quality Guidelines for the Protection of Agriculture</td>
<td>2005</td>
<td>Environment Canada</td>
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<td>Water Uses</td>
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<tr>
<td>Caring For The Greenzone: Riparian Areas and Grazing Management</td>
<td>2003</td>
<td>Cows and Fish Program, Alberta</td>
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<td>(3rd edition)</td>
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<td><a href="http://www.cowsandfish.org">www.cowsandfish.org</a></td>
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<tr>
<td>Cattle Wintering Sites: Managing for Good Stewardship</td>
<td>2001</td>
<td>Alberta Agriculture</td>
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<td>Chemigation Guidelines for British Columbia</td>
<td>1993</td>
<td>AGRI</td>
<td>578.100-1</td>
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<td>Choosing and Calibrating Manure Application Equipment</td>
<td>2005</td>
<td>AGRI</td>
<td>631.500-6</td>
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<tr>
<td>Climate Change Impacts and Adaptation: A Canadian Perspective</td>
<td>2004</td>
<td>Natural Resources Canada</td>
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<tr>
<td>Complying with the Fisheries Act</td>
<td>2001</td>
<td>DFO</td>
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<td>Conservation Buffers: Design Guidelines for Buffers,</td>
<td>2008</td>
<td>USDA / Forest Service Southern</td>
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<td>Corridors and Greenways</td>
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<td>Contingency Plan - Template for On-Farm Planning</td>
<td>2007</td>
<td>AGRI</td>
<td>390.100-0</td>
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<tr>
<td>Control of Beaver Damage</td>
<td>2001</td>
<td>Alberta Agriculture</td>
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<tr>
<td>Control of Insect and Related Pests of Livestock and Poultry in BC</td>
<td>2002</td>
<td>AGRI</td>
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<td><a href="http://www.agf.gov.bc.ca/cropprot/livestck.htm">http://www.agf.gov.bc.ca/cropprot/livestck.htm</a></td>
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<td><strong>Control of Rats and Mice on Poultry Farms</strong></td>
<td>1996</td>
<td>AGRI</td>
<td>384.200-6</td>
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<td><strong>Controlled Drainage/Subirrigation</strong></td>
<td>1998</td>
<td>AGRI</td>
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<td><strong>Crop Production Guides</strong></td>
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<td><a href="http://www.agf.gov.bc.ca/cropprot/prodguide.htm">http://www.agf.gov.bc.ca/cropprot/prodguide.htm</a></td>
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<td><strong>Cryptosporidium Infection</strong></td>
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<td>Ministry of Health Services <a href="http://www.healthlinkbc.ca/healthfiles/hfile48.stm">http://www.healthlinkbc.ca/healthfiles/hfile48.stm</a></td>
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<td><strong>Culvert Installation in Constructed Ditches</strong></td>
<td>2005</td>
<td>AGRI / DFO</td>
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<td><strong>Designing Tree Plantings for Wildlife</strong></td>
<td>2007</td>
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<td><strong>Drainage Management Guide</strong></td>
<td>2005</td>
<td>AGRI / BCAC</td>
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<tr>
<td><strong>Estimating Crop Residue Cover For Soil Erosion Control</strong></td>
<td>2000</td>
<td>AGRI</td>
<td>641.220-1</td>
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<td><strong>Energy Free Water Fountains</strong></td>
<td>2006</td>
<td>AGRI</td>
<td>590.307-4</td>
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<td><strong>Enhancing Livestock Water Quality</strong></td>
<td>2006</td>
<td>AGRI</td>
<td>590.301-4</td>
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<td><strong>Farm Nuisance – Dust</strong></td>
<td>2004</td>
<td>AGRI</td>
<td>870.218-62</td>
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<td><strong>Farm Nuisance – Odour</strong></td>
<td>2002</td>
<td>AGRI</td>
<td>870.218-64</td>
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<td><strong>Farm Practices – Manure Storage and Use</strong></td>
<td>2004</td>
<td>AGRI</td>
<td>870.218-44</td>
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<tr>
<td><strong>Farm Storage and Handling of Petroleum Products</strong></td>
<td>2005</td>
<td>AGRI</td>
<td>210.510-1</td>
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<td><strong>Farm Water Storage</strong></td>
<td>2003</td>
<td>AGRI</td>
<td>510.100-1</td>
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<tr>
<td><strong>Farms and Streams: Farmers Guide to Stream Stewardship</strong></td>
<td>1996</td>
<td>AAFC / AGRI</td>
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<td><strong>Farmstead Planning</strong></td>
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<td>AAFC #1674E</td>
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<td><strong>Feasibility Study – Anaerobic Digester and Gas Processing Facility in the Fraser Valley, British Columbia</strong></td>
<td>2007</td>
<td><a href="http://www.bcic.ca">www.bcic.ca</a></td>
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<td><strong>Feasibility Study – Biogas upgrading and grid injection in the Fraser Valley, British Columbia</strong></td>
<td>2008</td>
<td><a href="http://www.bcic.ca">www.bcic.ca</a></td>
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<td><strong>Field Crop Production Guide</strong></td>
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<td><strong>Field Guide to Invasive Alien Plant Pests and Diseases that Threaten BC Agriculture</strong></td>
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<td><strong>Field Guide to Harmful and Beneficial Insects and Mites of Tree Fruits</strong></td>
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<td><a href="http://www.agf.gov.bc.ca/cropprot/fieldguide/main.htm">www.agf.gov.bc.ca/cropprot/fieldguide/main.htm</a></td>
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<td><strong>Field Guide to Noxious and other Selected Weeds of BC</strong></td>
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<td><strong>Field Shelterbelts for Soil Conservation</strong></td>
<td>2007</td>
<td>Alberta Agriculture</td>
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<td><strong>Fine Particulates - What They Are and How They Affect Us</strong></td>
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<td>Fishery Timing Windows For Maintenance Work in Constructed Ditches</td>
<td>2005</td>
<td>AGRI / DFO</td>
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<td>Flood Construction Levels and Setbacks for Farm Building Situations</td>
<td>2008</td>
<td>AGRI</td>
<td>820.400-3</td>
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<td>Floriculture Production Guide</td>
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<td>Forage Production on Poorly Drained Soils in the Southern Interior of</td>
<td>1992</td>
<td>AGRI</td>
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<td>Freshwater Intake End-of-Pipe Fish Screen Guideline</td>
<td>1995</td>
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<td>512.100-1</td>
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<td>Fringe Benefits: A Landowner’s Guide to the Value and Stewardship of</td>
<td>1996</td>
<td>Ministry of Health Services</td>
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<td>Giardiasis (“Beaver Fever”)</td>
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<td><a href="http://www.bcgrasslands.org/monitoringmanual.htm">http://www.bcgrasslands.org/monitoringmanual.htm</a></td>
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<td>Grassed Waterways</td>
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<td>Grazing Management Guide</td>
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<td>Growing Greenhouse Peppers in British Columbia</td>
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<td>Guide for Bylaw Development in Farming Areas</td>
<td>1998</td>
<td>AGRI</td>
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<td>Guidelines for Canadian Drinking Water Quality</td>
<td>2008</td>
<td>Health Canada</td>
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<td>Guidelines for Farm Practices Involving Fill</td>
<td>2006</td>
<td>AGRI</td>
<td>820.200-1</td>
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<td>Guidelines for Minimum Standards in Water Well Construction</td>
<td>1982</td>
<td>MOE</td>
<td></td>
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<td>Guidelines for Off-Farm Inputs for Anaerobic Digestion Facilities</td>
<td>2010</td>
<td><a href="http://www.bcfarmbiogas.ca">www.bcfarmbiogas.ca</a></td>
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<td>Guidelines on Storage, Use &amp; Disposal of Wood Residue for the Protection of Fish &amp; Fish Habitat in British Columbia</td>
<td>1985</td>
<td>Environment Canada</td>
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<td>How to Disinfect Drinking Water</td>
<td></td>
<td>Ministry of Health Services</td>
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<td><a href="http://www.healthlinkbc.ca/healthfiles/hfile49b.stm">http://www.healthlinkbc.ca/healthfiles/hfile49b.stm</a></td>
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<td>Integrated Fruit Production Guide for Commercial Tree Fruit Growers</td>
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<td>Integrated Weed Management</td>
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<td><a href="http://www.agf.gov.bc.ca/cropprot/weedman.htm">www.agf.gov.bc.ca/cropprot/weedman.htm</a></td>
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<td>Invasive Plant Alert: Prevent the Escape of Aggressive Plants</td>
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<td><a href="http://www.agf.gov.bc.ca/cropprot/invasiplant.htm">http://www.agf.gov.bc.ca/cropprot/invasiplant.htm</a></td>
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<td>Irrigation Scheduling with Tensiometers</td>
<td>2006</td>
<td>AGRI</td>
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<td>Irrigation System Assessment Guide</td>
<td>2005</td>
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<td>Irrigation System Cross Connection Control</td>
<td>1985</td>
<td>AGRI</td>
<td>578.130-1</td>
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<td>Irrigation System Maintenance</td>
<td>1994</td>
<td>AGRI</td>
<td>577.200-1</td>
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<td>Irrigation Tips to Conserve Water on the Farm</td>
<td>2004</td>
<td>AGRI</td>
<td>500.310-1</td>
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<td>Key Drought Management Tips</td>
<td>2005</td>
<td>AGRI</td>
<td>665.000-2</td>
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<td>Lakes and Wetlands (a Caring For The Greenzone publication)</td>
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<td>Cows and Fish Program, Alberta <a href="http://www.cowsandfish.org">www.cowsandfish.org</a></td>
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<td>Land Management Guide for Horse Owners and Small-Lot Farmers</td>
<td>2008</td>
<td>Langley Environmental Partners Society</td>
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<tr>
<td>Landscaped Buffer Specifications</td>
<td>1993</td>
<td>Agricultural Land Commission</td>
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<td>Large Animal Disposal: On-Farm Burial Option</td>
<td>2006</td>
<td>AGRI</td>
<td>384.300-3</td>
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<td>Liming Acid Soils in Central B.C.</td>
<td>1991</td>
<td>AGRI</td>
<td>637.000-1</td>
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<td>Livestock Watering Requirements – Quantity and Quality</td>
<td>2006</td>
<td>AGRI</td>
<td>590.301-1</td>
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<td>Maintenance and Checking of Performance of Subsurface Drainage Systems</td>
<td>1985</td>
<td>AGRI</td>
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<td>Management Guide for Grapes</td>
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<td>Management of Dust in Broiler Operations</td>
<td>1999</td>
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<td>Management of Flies in Layer Barns</td>
<td>2008</td>
<td>AGRI</td>
<td>305.104-1</td>
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<td>Manure Treatment Options vs. Available Land Base</td>
<td>1994</td>
<td>AGRI</td>
<td>382.910-1</td>
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<td>Mitigating Cattle Losses Caused by Wild Predators in British Columbia</td>
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<td>Nursery and Landscape Pest Management &amp; Production Guide</td>
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<td>On-Farm Anaerobic Digestion Waste Discharge Authorization Guideline</td>
<td>2010</td>
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<td>On-Farm Hydroelectric Generation</td>
<td>2006</td>
<td>AGRI</td>
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<td>On Farm Pesticide Storage and Handling Facility</td>
<td>1994</td>
<td>AGRI</td>
<td>373.130-2</td>
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<td>On-Site Testing of Growing Media and Irrigation Water</td>
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<td>Plug and Bedding Plant – Water, Media and Nutrition</td>
<td>1998</td>
<td>AGRI</td>
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<td>Preparing a Complete Nutrient Solution</td>
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<td>Protecting Your Shorelands for Better Farming and Ranching, and Healthier Fish Habitat</td>
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<td>Pumping Livestock Water - It's All About the Energy Choices!</td>
<td>2005</td>
<td>AGRI</td>
<td>590.305-1</td>
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<td>Reducing Nitrogen and Phosphorus in Manure Through Ration Changes</td>
<td>1993</td>
<td>AGRI</td>
<td>382.910-2</td>
</tr>
<tr>
<td>Riparian Areas - A Users Guide to Health</td>
<td>2003</td>
<td>Cows and Fish Program, Alberta</td>
<td><a href="http://www.cowsandfish.org">www.cowsandfish.org</a></td>
</tr>
<tr>
<td>Riparian Health Assessment for Streams and Small Rivers - Field Workbook (a Caring For The Greenzone publication)</td>
<td>2008</td>
<td>Cows and Fish Program, Alberta</td>
<td><a href="http://www.cowsandfish.org">www.cowsandfish.org</a></td>
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<td>Riparian Management Field Workbook</td>
<td>2005</td>
<td>AGRI/ BCAC</td>
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<tr>
<td>Rotten Luck: The Role of Downed Wood in Ecosystems.</td>
<td>1995</td>
<td>Fraser River Action Plan</td>
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<td>Fraser River Action Plan</td>
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<td>Siting and Management of Poultry Barns</td>
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<td>305.104-1</td>
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<td>Sizing Dairy Manure Storage Facilities</td>
<td>1990</td>
<td>AGRI</td>
<td>383.100-2</td>
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<tr>
<td>Soil Compaction - A Review of its Origin and Characteristics</td>
<td>1990</td>
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<td>613.100-1</td>
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<td>Soil Liming - Understanding Your Soil Test Recommendation</td>
<td>1993</td>
<td>AGRI</td>
<td>637.200-1</td>
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<td>Soil Management Handbook for the Lower Fraser Valley</td>
<td>1991</td>
<td>AGRI</td>
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<td>Soil Management Handbook for the Okanagan and Similkameen Valleys</td>
<td>1994</td>
<td>AGRI</td>
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<td>AGRI</td>
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<td>AGRI</td>
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<td>AGRI</td>
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<td>Sprinkler Irrigation Scheduling using a Water Budget Method</td>
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<td>Soil Water Storage Capacity and Available Soil Moisture</td>
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<td>AGRI</td>
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<td>Standards and Best Practices for Instream Works (lower mainland)</td>
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<td>MOE</td>
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<td>2000</td>
<td>AGRI</td>
<td>384.200-7</td>
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<tr>
<td>Stewardship Options for Private Landowners in B.C.</td>
<td>1996</td>
<td>Environment Canada / MOE</td>
<td></td>
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<tr>
<td>Suggestions For Field Sprayer Operation And Maintenance</td>
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<td>2000</td>
<td>AAFC</td>
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<td>The RUSLEFAC – Revised Universal Soil Loss Equation for Application in Canada</td>
<td>2002</td>
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<td></td>
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<tr>
<td>Treating Irrigation and Crop Wash Water for Pathogens</td>
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<td>AGRI</td>
<td>5121.000-3</td>
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<td>Treatment of Greenhouse Recirculation Water - Biosand Filtration</td>
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<td>Trees and Shrubs for Prairie Shelterbelts</td>
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<td>Use Caution When Bringing Non-Agricultural Waste or Products onto Your Farm</td>
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<td>Water-Borne Diseases in BC</td>
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<td>Water License Holders Rights and Obligations</td>
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<td>Water Quality Evaluation of Agricultural Runoff in the Lower Fraser Valley</td>
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<td>Woodwaste Use - Precautions To Horse Owners</td>
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<td>AGRI</td>
<td>655.000-2</td>
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<td>1992</td>
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## C.2 WEBSITES

The following websites are referenced in this Guide for further details on environmentally-related subjects.

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### Ministry of Agriculture  http://www.gov.bc.ca/al/ |

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### Ministry of Forests, Mines and Lands  www.gov.bc.ca/for |

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- http://www.healthlinkbc.ca/healthfiles/httoc.stm
  - Health Files - Factsheets

### Federal Government

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### Local Government and Other Websites

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<td>Anaerobic Digestion Initiative Advisory Committee of BC</td>
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<td><a href="http://www.bcgw.ca">www.bcgw.ca</a></td>
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<td><a href="http://www.bcagclimateaction.ca">www.bcagclimateaction.ca</a></td>
<td>BC Agrifood Knowledge Platform (a collection of commodity specific documents)</td>
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<td><a href="http://www.kmwpp.ca/">www.kmwpp.ca/</a></td>
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<td><a href="http://www.bcagclimateaction.ca">http://www.bcagclimateaction.ca</a></td>
<td>BC Agriculture Council</td>
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<td><a href="http://www.arb.ca.gov/diesel/verdev/vt/cvt.htm">www.arb.ca.gov/diesel/verdev/vt/cvt.htm</a></td>
<td>California Air Resource Board</td>
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<td><a href="http://www.cleanfarms.ca">www.cleanfarms.ca</a></td>
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<td>.www.c-ciam.uoguelph.ca</td>
<td>Climate Change Adaptation</td>
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<td><a href="http://www.deltafarmland.ca">www.deltafarmland.ca</a></td>
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<td><a href="http://www.farm-energy.ca">www.farm-energy.ca</a></td>
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<td><a href="http://www.metrovancouver.org/boards/bylaws/Bylaws/GVRD_Bylaw_1098.pdf">www.metrovancouver.org/boards/bylaws/Bylaws/GVRD_Bylaw_1098.pdf</a></td>
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<td><a href="http://www.trenchsociety.com">www.trenchsociety.com</a></td>
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D GLOSSARY OF TERMS

The following are terms used in this Reference Guide, as well as other closely related terms.

**100 year flood**: a flood of such a magnitude that the chance of it being equaled or exceeded in any given year is at least one in one hundred

**100 year floodplain**: land where the chance of a flood occurring in any given year is at least one in one hundred

**100 year peak flow**: a watercourse flow where the chance of a peak flow occurring in any given year is at least one in one hundred

**Abattoir**: facility for butchering animals; may include wrapping, freezing and processing facilities

**Absorption**: the incorporation of a substance into the body of another (also see adsorption)

**Acre-foot**: the amount of water that will cover one acre to a depth of one foot; equal to 1,233.84 m³, [1,233,840 L], or 43,560 ft³ [325,829 US gal]

**Adaptation**: adjustment of agri-food practices to maintain competitive production advantages during comparatively rapid changes in the regional climate

**Adsorption**: the attachment or adhesion of a substance generally onto the surface of another solid material (also see absorption)

**Aeration**: providing optimum availability of air in a material, such as into soil for crop growth

**Aerator with dribble bar**: a system to apply manure in bands onto soil behind a soil aerator

**Aerobic**: the presence of sufficient oxygen in a biological decomposition process (e.g., composting) to allow oxygen consuming microbes to flourish (also see anaerobic)

**Afforestation**: [from Environment Canada] The direct human-induced conversion of land that has not been forested since December 31, 1989 to forested land through planting, seeding and/or the human-induced promotion of natural seed sources

**Aggregates**: grouping of soil particles cohering so as to behave mechanically as a unit; the way in which aggregates are grouped together is called soil structure (also see soil)

**AGRI**: British Columbia Ministry of Agriculture

**Agricultural exemptions of approvals/permits**: see waste discharge

**Agriculture Land Reserve**: a provincial-wide land classification under the Agriculture Land Reserve Act

**Agricultural waste**: [from the Code under the Agricultural Waste Control Regulation] includes manure, spent mushroom medium, and agricultural vegetation waste, such as crop residue, unmarketable produce, and spoiled feed

**Agricultural waste composting**: see compost

**Agricultural waste used as a fertilizer**: application of agricultural waste according to its fertilizer value (also see fertilizer)

**Agroforestry**: a land management approach that deliberately combines the production of trees with other crops and/or livestock

**Air**: [from the Environmental Management Act] the atmosphere but does not include the atmosphere inside a human made enclosure that is not open to the weather (also see atmosphere)

**Air contaminant**: see contaminant

**Air gap**: an open air space (at least 30 cm, suggested) between a hose or tap from a potable water source and the water level of non-potable water; maintained so as to prevent backflow contamination of the potable water source, such as when filling pesticide sprayers (also see backflow)
air shed: a geographic region that shares an air mass that has similar characteristics and is separated from other air masses by weather patterns or topography

algae: aquatic plants that lack true stems, roots or leaves and are often green, blue-green or brown in colour

algae bloom: rapid growth of algae in water due to high nutrient levels

anaerobic: the absence of oxygen in a biological decomposition process. (e.g., bio-gas or methane production); may occur in soil or water (also see aerobic)

anhydrous ammonia: is a chemical fertilizer (NH₃) whose properties make it one of the most potentially dangerous chemicals on a farm; anhydrous means without water; consequently, when anhydrous ammonia and moisture come into contact, they rapidly combine; when it is injected into the soil, the liquid ammonia expands into a gas and is readily absorbed in the soil moisture; usually provided to a farm by a contracted applicator

annual: a plant that lives for one year or season

anti-siphon device: see fuel storage

antisapstain chemical: (a) treatment chemical applied to processed wood which make the woodwaste unsuitable for use on farms; (b) [from the Antisapstain Chemical Waste Control Regulation] chlorophenol, 2-(thiocyanomethylthio) benzothiazole (TCMTB), copper-8-quinolinolate (Cu-8), 3-iodo-2-propynyl butyl carbamate (IPBC) and didecyldimethyl ammonium chloride (DDAC)

approval: [from the Water Act] approval under section 8 (short-term use of water) or approval under section 9 (changes in and about a stream)

aquatic life: plant and animal life growing or living in or near water (also see species)

aquifer: a geologic formation, group of formations, or part of a formation capable of storing, receiving and transmitting water; the formation is capable of yielding enough water to support a well or spring

artesian aquifer: contains water under pressure as a result of hydrostatic head; also called a confined aquifer (also see well–artesian well)

confined aquifer: an aquifer overlain by a confining layer of impermeable soil or rock material; the water table is separated from the atmosphere by the impermeable layer; this type of aquifer is sometimes called an artesian aquifer

unconfined aquifer: an aquifer without an upper confining layer of impermeable soil or rock material; the water surface is exposed to the atmosphere through a series of interconnected openings in the overlying permeable soil and/or rock layers and is in equilibrium with atmosphere pressure; particularly susceptible to entry of surface contaminates; the water surface is called the water table (also see water table)

artesian: see aquifer and see well

atmosphere: the layer of gases surrounding the earth, composed primarily of nitrogen, hydrogen and oxygen

authorization: as required under the federal Fisheries Act Section 35(2) regarding any works that may harm fish habitat

avoid: to employ, practice or implement risk treatment measures to prevent (eliminate) or reduce (mitigate) the occurrence of pollution, damage and/or the deposit of deleterious substance into the environment. The natural characteristics of a site such as soil properties, topographic conditions, depth to groundwater or annual precipitation may help to mitigate environmental risk.

backflow: the reverse flow of a liquid from the distribution system back to the water source, such as from a sudden pressure drop in a supply line creating a siphon-back condition; the source may become contaminated

backflow prevention: piping arrangements to protect a water source, such as vacuum breakers or automatic valves, whereby the supply water is prevented from reverse flow (also see air gap; backflow can be prevented if the supply pipe is kept away from any contaminated liquids, such as keeping pesticide sprayer filling water lines above and separate from the sprayer tank)

bacteria: a large group of single-celled microscopic organisms lacking an organized nucleus; some can cause disease, such as Salmonella or Cholera

coliform bacteria: bacteria found in faeces, soil, and vegetation, which is used to indicate the bacteriological quality of water; given as “total coliforms” in a water test
**E.coli**: bacteria sometimes found in under-cooked meat, such as ground beef; causes “hamburger disease”

**fecal coliform**: bacteria present in virtually all warm-blooded animals; commonly used as an indicator organism in water contamination testing due to low testing cost; given as “fecal coliforms” in a water test (also see fecal)

**banding**: see fertilizer: side dressing

**baseflow**: the amount of water in a stream that results from normal conditions (groundwater discharge) rather than from storm conditions or releases from storages such as reservoirs

**bathymetric**: the measurement of water depth at various location in a body of water, as is done to establish the volume of a reservoir

**bed-level**: see stream crossing

**beneficial management practice**: see BMP

**berm**: a constructed strip or ridge of soil to divert or retain runoff, such as an embankment, but not a dyke (also see dyke)

**bioaccumulate**: the process by which certain chemicals are consumed and retained by organisms, either from the environment directly or by eating food containing the chemicals

**biodegradable**: capable of being broken down by living organisms into inorganic compounds

**biodiversity**: [from the Canadian Environmental Protection Act] the variability among living organisms from all sources, including, without limiting the generality of the foregoing, terrestrial and marine and other aquatic ecosystems and the ecological complexes of which they form a part and includes the diversity within and between species and of ecosystems (also see species and ecosystem)

**biofilter**: an air filtration system that exhausts air up through a bed of fibrous organic material, as may be used for a mushroom composting facility to extract odours and other compounds from the exhaust air

**BOD or biological oxygen demand**: see oxygen demand

**biosolids**: [from the Organic Matter Recycling Regulation] stabilized municipal sewage sludge resulting from a municipal waste water treatment process or septage treatment process which has been sufficiently treated to reduce pathogen densities and vector attraction to allow the sludge to be beneficially recycled in accordance with the requirements of this regulation

**boiler**: a vessel used for generating hot water or steam, typically fuelled by natural gas, oil, or solid fuels such as wood or coal

**emission standards**: are set by Local Government and by the Code under the Agricultural Waste Control Regulation

**BMP or beneficial management practice**: a structural, non-structural, or managerial technique recognized to be an effective and practical means to reduce or remove the risk of pollution occurring while still allowing the productive use of resources

**blind inlet**: also know as a french drain; allows surface water to percolate to subsurface drainage systems; used when the quantity of surface water is small or the sediment load is heavy (refer to page 190 of BC Agricultural Drainage Manual)

**browse**: (noun) woody forage, such as leaves and shoots of plants, eaten by animals; (verb) to search for or consume browse

**browsing**: consumption of woody forage from trees and shrubs (also see grazing)

**buffer**: a specially managed area that is used to separate farm activities from sensitive areas, such as a strip of crop vegetation, often grass or trees; some can act as a “treatment system” to remove contaminants before they reach the sensitive area

**permanent vegetated buffer**: a strip of permanent vegetation which separates an environmentally-sensitive area from farm areas

**pesticide drift buffer**: setbacks from areas where pesticide application occurs, generally intended for watercourses or for non-target terrestrial areas

**filter strip**: may contain grasses, trees, or other dryland plants to help filter soil particles out of runoff

**visual buffer**: a vegetated buffer that is used primarily to alter aesthetic impact

**building**: farm structures to store farm supplies or equipment or to house livestock

**building code**: safety measures legally required for farm buildings contained in the National Farm Building Code of Canada; only enforced where proclaimed by local government

**perimeter drain**: see perimeter drain

**building setback**: see setback
burning: see open fires and see outdoor burning

C:N or carbon-nitrogen ratio: the ratio of the weight of organic carbon to that of total nitrogen in an organic material; important ratio when composting organic material such as woodwaste, where it should only be applied to soils having a C:N ratio of 30:1 or lower

calibration: see pesticide and nutrient

carbon dioxide (CO₂): a greenhouse gas produced by the combustion of fossil fuels and biomass and from deforestation or clearing of agricultural land. It is a major contributor to the greenhouse effect and is therefore associated with climate change

carbon monoxide (CO): an air contaminant that originates mainly from the combustion of fuels used to heat buildings and greenhouses, and to power farm equipment; at high concentrations the gas can cause asphyxiation, and at lower levels it produces symptoms of impaired perception and reflexes

carbon offsets: reduction and sequestration projects can generate carbon offsets. It is possible to market carbon offsets as a product if it can be proven that the activity or change in activity results in a real and permanent reduction in GHG’s in the atmosphere.

carbon sequestration: plants and soil organic matter play an important role in removing carbon dioxide from the air and storing (sequestering) it. Carbon is the main component in plant material and soil organic matter. Any uptake of carbon dioxide from the air by plant material or soil reduces the effects of climate change

casing: see well casing

catch basin: any excavated, dyked, or walled structure, or combination of structures, designed to intercept and temporary store runoff contaminated by farm waste

catch crop: a crop planted with the specific goal of catching available soil nutrients which would otherwise be lost by leaching

calving pen: see confined livestock area

changes in and about a stream: [from the Water Act] (a) any modification to the nature of a stream including the land, vegetation, natural environment or flow of water within a stream, or (b) any activity or construction within the stream channel that has or may have an impact on a stream, refer to page 9-8

channelized stream: permanent or relocated streams that have been dyked, diverted or straightened and carry drainage flows from headwaters or significant sources of groundwater. Reaches of channelized streams may be confined by roads and fences and in many cases can also meander through fields.

Man made channels that divert irrigation water from a stream but return overflow water back to a stream in a manner that allows fish access are classified as channelized streams.

chemical fertilizer: see fertilizer

chemigation: application of a chemical (such as a fertilizer or pesticide) to a crop through an irrigation system by mixing them with the irrigation water

backflow: see backflow

chemigation guidelines: a series of recommended practices outlined in the publication Chemigation Guidelines for BC

spent nutrient solution: the water and nutrient solution that is left over after fertilizing via chemigation

cistern: a non-pressurized tank for storing water

Class A Compost: as defined by the Organic Matter Recycling Regulation – see page A-6

clean water: see water quality

climate change: [from the United Nations Framework Convention on Climate Change (UNFCCC), Article 1] a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods

Code: the Code of Agricultural Practice for Waste Management, April 1, 1992 attached to the Agricultural Waste Control Regulation of both the Environmental Management Act and Public Health Act

coliform: see bacteria

compaction: see soil

compost: [from the Organic Matter Recycling Regulation] a product which is (a) a stabilized earthy
matter having the properties and structure of humus, (b) beneficial to plant growth when used as a soil amendment, (c) produced by composting, and (d) only derived from organic matter

**agricultural waste composting**: [from the Organic Matter Recycling Regulation] the composting of agricultural waste in accordance with Part 5 of the Code under the Agricultural Waste Control Regulation

**composting**: [from the Organic Matter Recycling Regulation] the controlled biological oxidation and decomposition of organic matter in accordance with the time and temperature requirements specified in Schedule 1 of the Regulation

**compost bulking agent**: an ingredient in a mixture of composting raw materials included to improve the structure and porosity of the mix, e.g., sawdust

**compost leachate**: water passing through uncovered compost piles will produce various compounds which can pollute water and must be contained; in high rainfall areas, piles should not be on uncovered areas on bare ground but should be covered and on a surface such as concrete

**composting site**: the location of the organic material being composted, including buildings, clean water diversion, runoff collection and visual screening where used, as shown in Figure 2.3, page 2-29

**curing area**: [from the Organic Matter Recycling Regulation] an area where organic matter which has undergone the rapid initial stage of composting is further matured into a humus-like material

**concentrated flow**: see overland flow

**concern**: (a) something of interest or importance, a responsibility; (b) worry, anxiety

**concrete**: a mixture of Portland cement, water, air, and aggregates (sand and gravel)

**fly ash additive**: replaces a part of the cement in the mix, to indirectly reduce air pollution by virtue of reduced fuel use in what is a high energy use process

**confined livestock area**: [from the Code under the Agricultural Waste Control Regulation] an outdoor, non-grazing area where livestock, poultry or farmed game is confined by fences, other structures or topography including feedlots, paddocks, corrals, exercise yards and holding areas, but not including a seasonal feeding area

**calving pen**: a confined livestock area used to birth cattle

**feedlot**: a confined livestock area for the finishing-feeding of livestock

**horse riding arena**: a confined livestock area used for riding horses

**permanent vegetated buffer**: see buffer

**soil-based**: see soil-based yard

**conifer**: a cone-bearing tree

**conservation**: the continuing protection and management of natural resources in accordance with principles that assure their optimum long-term economic and social benefits

**productive conservation**: a practice designed and managed simultaneously to protect the environment and to provide economic returns, such as riparian management that protects both the water resource and biodiversity while providing livestock grazing or a harvestable crop such as berries or floral products

**conservation tillage**: see tillage

**constructed channels**: man made drainage channels that carry drainage water from more than one property but do not carry water from headwaters or significant sources of groundwater; flows in agricultural constructed channels may be year round and are not regulated; constructed channels may also deliver water for irrigation purposes

**constructed ditches**: man made drainage channels that carry drainage water from one property but do not carry water from headwaters or significant sources of groundwater; flows in agricultural constructed ditches may be year round and are not regulated; may also deliver water for irrigation purposes

**contaminant**: anything added to a substance that makes the substance impure or unfit for its intended use (see deleterious substance and pollutant)

**air contaminant**: [from the Environmental Management Act] a substance that is emitted into the air and that (a) injures or is capable of injuring the health or safety of a person, (b) injures or is capable of injuring property or any life form, (c) interferes or is capable of interfering with visibility, (d) interferes or is capable of interfering with the normal conduct of business, (e) causes or is capable of causing material physical discomfort to a person, or (f) damages or is capable of damaging the environment
potential contaminant: any material handled, stored or used on a farm that if allowed to enter the environment (other than when normally used) would cause pollution, such as petroleum or pesticide losses from storage; to be considered when locating farm storages, dispensing sites, etc.

secure containment of potential contaminants: structures and practices that take into account the appropriate environmental risks associated with handling, storing and using various farm materials

corral: a small enclosure for handling livestock

cover crop: plants grown alone or in mixtures for protection of the soil against erosion, amelioration of soil structure, enhancement of soil fertility, suppression of pests and alteration of micro-climate; not generally grown for harvest or forage, but rather to fill gaps in either time or space when cash crops leave the soil bare; also known as: green manure, living or dead mulches, plough down, companion, relay, double or catch crops

relay crop: a method of cover cropping where a cover is seeded before the main crop is harvested to reduce weed growth during the growing season and ensure cover establishment

critical habitat: see habitat

crops: includes all agricultural crops

stewardship crops: crop and non-crop plantings for land and/or stewardship purposes, such as lure or sacrifice crops grown to draw wildlife away from cash crops (also see stewardship)

crop drying: the process of removing moisture from a crop to prevent spoilage and allow storage

aeration drying: the process by which natural air is blown through a crop for drying, usually without auxiliary heat

automatic controls: crop drying equipment operated with feedback from air and crop conditions of temperature and humidity, such that energy use is optimized

crop production: farming where plants are grown for various purposes, such as livestock or human feed

crop rotation: a succession of different crops planted on the same land, as opposed to growing the same crop time after time; to improve yields and soil health, and improve pest control

crop residue: (a) the portion of a plant or crop left in the field after harvest, usually having soil benefits; (b) crop prunings, waste plants and other organic matter that may be used as a soil conditioner (also see soil)

outdoor crop: crops grown without cover of buildings, such as field crops

intensively-managed: continuous crop production with fertilizer and irrigation, as required to maximize output during the crop growing season
**crop storage**: area where harvested crops are stored, with water contamination prevention measures in place, such as silos with silage effluent collection

**covered crop storage**: storage constructed to protect the crop from deterioration from the weather, such as roofed hay storage

**cross connection**: a situation where piping carrying contaminated liquid is connected to piping containing clean liquid, such as water; usually connected mistakenly

**Crown land**: land, whether or not it is covered by water, or an interest in land, vested in the Crown

**Cryptosporidium parvum**: “crypto”; a microscopic coccidian pathogen of most mammals; is transmitted by water and can infect humans; transmission occurs by way of oocysts which are highly resistant to destruction (very young beef and dairy calves may carry the organism for a short time)

**culvert**: a transverse drain, such as to flow water under a road; must be sized for both expected water flow and, where present, for fish passage (also see free passage of water and fish)

**open channel culvert**: is one that does not flow full (termed a pipe if full)

**inlet structure**: where required, allows proper flow and protects for the surrounding structure; may include debris catcher

**outlet structure**: where required, decreases erosion potential and allows fish entry

**culvert**: a transverse drain, such as to flow water under a road; must be sized for both expected water flow and, where present, for fish passage (also see free passage of water and fish)

**dam**: a structure of earth, rock, concrete, or other material designed to retain water, creating a pond, lake, or reservoir; typically requires a water licence to store water (also see water licence)

**dangerous wildlife**: see wildlife

**deforestation**: [from Environment Canada] permanent, human-induced land use change from forest to non-forest land cover. Forest harvesting, including clearcutting, is not considered deforestation, as the land use does not change and the land cover is expected to revert to forest.

**zero net deforestation**: is achieved when the area of afforestation is equal to or greater than the area of deforestation.

**deleterious substance**: [condensed from the federal Fisheries Act] any substance that, if added to any water, would degrade or alter the quality of that water so that it is likely to be deleterious (harmful) to fish or fish habitat or to the use by man of fish that frequent that water (also see contamination and pollution)

**detention pond**: see stormwater

**direct farm sales**: see on-farm

**discharge**: total amount of a solid, liquid or gaseous material introduced into the environment from works

**disposal**: the introduction of waste into the environment through any discharge, deposit, emission or release to any land, water or air by means of facilities designed, constructed and operated so as to minimize the effect on the environment

**dirty water**: see water quality

**dissolved oxygen**: the amount of oxygen dissolved in a given quantity of water at a given temperature and pressure; usually expressed as a concentration in parts per million, or as a percentage of saturation

**ditch**: a waterway constructed to intercept surface runoff and to act as an outlet for subsurface drainage (also see “constructed ditch”)

**diversion**: a channel or dam constructed across a slope to intercept surface water flow and transfer it to a safe or convenient discharge point, such as placed for a water system intake, or used above a area to be protected from surface water flow

**point of diversion**: [from the Water Regulation] the place on the natural channel of a stream where an applicant proposes, or a licensee is authorized, to divert water from the stream

**domestic purpose**: (a) [from the Drinking Water Protection Act] the use of water for (a) human consumption, food preparation or sanitation, (b) household purposes not covered by paragraph (a), or (c) other prescribed purposes; (b) [from the Water Act] the use of water for household requirements, sanitation and fire prevention, the watering of domestic animals and poultry and the irrigation of a garden not exceeding 1,012 m² adjoining and occupied with a dwelling house

**domestic water sources**: surface water or groundwater that is used or intended to be used for domestic purposes
domestic water system: [from the Drinking Water Protection Act] a system by which water is provided or offered for domestic purposes, including (a) works used to obtain intake water, (b) equipment, works and facilities used for treatment, diversion, storage, pumping, transmission and distribution, (c) any other equipment, works or facilities prescribed by regulation as being included, (d) a tank truck, vehicle water tank or other prescribed means of transporting drinking water, whether or not there are any related works or facilities, and (e) the intake water and the water in the system, but excluding equipment, works or facilities prescribed by regulation as being excluded.

drinking water: [from the Drinking Water Protection Act] water used or intended to be used for domestic purposes.

drinking water health hazard: [from the Drinking Water Protection Act] (a) a condition or thing in relation to drinking water that does or is likely to (i) endanger the public health, or (ii) prevent or hinder the prevention or suppression of disease; (b) a prescribed condition or thing; or, (c) a prescribed condition or thing that fails to meet a prescribed standard.

drinking water source: [from the Drinking Water Protection Act] a stream, reservoir, well or aquifer from which drinking water is taken.

drainage: the removal of excess water from the land surface and/or from the soil profile.

drainage maintenance: work required to ensure the operation of a drainage system; must be conducted (methods and timing) to minimize impacts to riparian areas and water quality.

drainage water quality: see water quality.

surface drainage system: designed system using natural or constructed channels and ditches open to the land surface being drained; may include water control structures to allow controlled backflooding crop land.

subsurface drainage system: a system using drain tiles or perforated pipes buried under the land surface being drained, including the collection of drains, structures and pumps, having three modes as follows:

1. conventional subsurface system: designed solely for the removal and disposal of excess water.
2. controlled drainage system: a system where the outflow is controlled to maintain an effective drainage depth; used to conserve water; a type of subirrigation where no additional water is added; may have the capacity to isolate and allow management of contaminated runoff.

3. subirrigation drainage: a controlled drainage system where additional water can be added to backflow into the soil to raise the water table as required for irrigation of a crop; must be designed for both drainage and irrigation needs.

drawdown: see wells.

drift: see off target.

drop structure: used to remove erosive energy from water moving down a grassed waterway or ditch.

drought: (a) a prolonged chronic shortage of water, as compared to the norm, often associated with high temperatures and winds during spring, summer and fall; (b) a period without precipitation during which the soil water content is reduced to such an extent that plants suffer from lack of water.

dry matter content: percent of total product weight which is not water; equals 100 minus moisture content.

due diligence: a principle whereby an accused can avoid liability only by providing that they took all reasonable care to avoid a situation; demonstrating your actions represent a reasonable approach to a problem is due diligence, ignoring it and hoping it will go away is not.

dump and grade: a system to apply manure on the soil surface by dumping truck loads on the ground and then spreading the manure by using a grader type of equipment.

dugout: a constructed depression that collects and stores water and differs from a reservoir in that a dam is not relied upon to impound water; may or may not be water licenced.

dust: see particulates.

dwelling, private: [from the Drinking Water Protection and Public Health Acts] (a) a structure that is occupied as a private residence, or (b) if only part of a structure is occupied as a private residence, that part of the structure.

dyke: an artificial embankment constructed to prevent flooding.
Ecosystem: the complex set of interactions between living organisms and their environment; ecosystems include plants, insects, fish, birds, animals, water and soil.

E. coli: see bacteria.

efficient: the use equipment or methods such that energy needs or use are minimized, such as the use of low energy lighting or high efficiency motors.

Effluent: (1) [from the Environmental Management Act] a substance that is discharged into water or onto land and that (a) injures or is capable of injuring the health or safety of a person, (b) injures or is capable of injuring property or any life form, (c) interferes or is capable of interfering with visibility, (d) interferes or is capable of interfering with the normal conduct of business, (e) causes or is capable of causing material physical discomfort to a person, or (f) damages or is capable of damaging the environment; (2) [from the Sewerage System Regulation] domestic sewage that has been treated by a treatment method and discharged into a discharge area.

EC or electrical conductivity: a measure of the ability of water to conduct electricity; used to estimate the amount of soluble salts in water and soil water.

Emergency contacts and emergency plan: see contingency plan.

Emission: total amount of a solid, liquid or gaseous material emitted into the atmosphere from works.

Energy efficiency: the greatest possible reduction of the total amount of energy needed.

Enteric fermentation: a process that takes place in ruminant livestock which converts carbon in feed to methane; contributes to a net increase in atmospheric methane concentrations.

Environment: [from the Environmental Management Act] the air, land, water and all other external conditions or influences under which humans, animals and plants live or are developed.

Environmental assessment: the critical appraisal of the likely effects of a proposed or existing project, activity, or policy on the environment, both positive and negative.

Environmental impact: a measurable change to the environment from an activity or action; may be negative or positive.

Environmentally sensitive area: may be a sensitive water body, habitat area or wildlife population on a non-production area on a farm that is sensitive to farm activities, such as contaminated runoff of pesticide drift.

ephemeral: see stream.

Erosion: the detachment and movement of soil and rock particles by gravity, wind, water, freezing and thawing, and/or other natural phenomena and may be intensified by human land use practices; erosion is a source of sediments, suspended solids, total dissolved solids and particulate matter turbidity in natural waters.

Incision: vertical erosion (downcutting) of a stream channel; a stream is considered “incised” when the normal two-year high water flow cannot reach the floodplain.

Lateral cutting: erosion of a stream bank as the water channel moves sideways.

Rill erosion: small channels that form in the soil as a result of surface water flow; they are easily removed when the soil is worked with farm equipment.

Sheet erosion: the loss of a uniform layer of soil by wind or water, evidenced by exposure of once hidden roots or stones.

Scour: erosion that occurs along stream banks and in stream beds through water action.

Eutrophication: the natural process by which lakes or ponds become enriched with dissolved nutrients resulting in increased algae and plant growth; may be natural or accelerated by human activities.

Evaporation: the process of liquid water becoming water vapour from water surfaces, land surfaces and snow.

ET or evapotranspiration: the combined loss of water to the atmosphere from a given area by evaporation from the land and transpiration from plants; used in determining crop irrigation needs (also see evaporation and transpiration).

Exotic pest: see pest.
farmstead: the main area of a farm or ranch; it is usually where the home site is located, where machinery, fertilizers, chemicals, etc. are stored, and where the major livestock buildings are located.

fecal: waste matter, feces, from the gut or gastrointestinal tract of animals

fecal coliform: see bacteria

feed bunk: a structure, either portable or permanent, in which feed can be placed for convenient access by livestock

portable feed bunk: a movable-location structure which is moved so as to distribute manure over the feeding area, usually crop land (when used on non-crop land or when not moved, the manure should be managed as for a permanent feed bunk)

permanent feed bunk: a fixed-location structure which requires manure to be scrapped and removed for spreading onto crop land

feedlot: see confined livestock area

fertilizer: any natural or manufactured material, either organic or inorganic, that is added to soil to supply one or more plant nutrients, but not managed as a soil conditioner (also see soil – soil conditioner)

chemical fertilizer: a manufactured or processed fertilizer with a known chemical content

organic fertilizer: manure or compost

fertilizer versus soil conditioner: materials that have properties that allow them to be used as both a fertilizer and a soil conditioner should be managed as a fertilizer; see Tables 6.4 and 6.5, pages 6-6 and 6-7

side dress: fertilizer applied as a band between rows of a growing crop

fertigation: the application of nutrients through an irrigation or nutrient circulation system (also see chemigation)

field capacity: the amount of water remaining in a soil when the downward water flow due to gravity becomes negligible

filter strip: see buffer

fish: [from the federal Fisheries Act] includes fish or parts of fish, shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals

fish bearing stream: a stream that has, or is likely to have, fish at anytime

fish habitat: see habitat

fish passage: [from the Water Act] fish in a stream are able to pass by or through in both upstream and downstream directions

fish screening: see intake

wildlife, fish: see wildlife

flail broadcast: a system to apply manure on the soil surface that uses a flail to throw and spread the manure

flood: the temporary inundation of normally dry land areas resulting from the overflowing of the natural or artificial confines of a watercourse

floodplain: relatively flat, low lying areas next to watercourses that are periodically flooded

active floodplain: the area of land that is flooded every 2 to 3 years

flotation: ability of tractor or implement tires to stay on top of soil surface; usually related to soil conditions, equipment weight, and contact area between tires and soil surface

flow: the rate of water discharged from a source, expressed in a volume over a time period, such as cubic metres per second (m³/s)

fly ash: fine, solid, non-combustible particles removed from combustion exhaust gasses used as an additive in concrete to reduce cement requirements, indirectly reducing energy costs and air pollution

food: [from the Food Premises Regulation] any raw or processed substance intended for human consumption

food premises: [from the Food Premises Regulation] any place where food intended for public consumption is sold, offered for sale, supplied, handled, prepared, packaged, displayed, served, processed, stored, transported or dispensed

forage: plants that are grown for animal feed

forb: any broad-leafed, flowering plant with non-woody stem that is not a grass or grass-like plant
**forest**: [from Environment Canada] a minimum area of one hectare, at least 20 meters wide, with tree crown cover (or equivalent stocking level) of more than 25% with trees having the potential to reach a minimum height of 5 metres at maturity. A forest may consist of closed forest formations (where trees of various storeys and undergrowth cover a high proportion of the ground) or open forest. Young natural stands and all plantations which have yet to reach a crown density of 25% or tree height of 5 metres are considered to be forest. As well, forest includes areas normally forming part of the forest area that are temporarily unstocked as a result of human intervention (such as harvesting) or natural causes, but which are expected to revert to forest.

**fossil fuel**: fuel (e.g. oil, gasoline, diesel, propane and natural gas) that is produced from carbon chains that have been stored underground for millions of years. When combusted, these fuels release carbon dioxide into the atmosphere.

**freeboard**: the distance between the full storage level and the upper edge of the storage structure; provided to prevent overtopping due to unforeseen conditions (i.e., for water in a ditch it is the distance from the surface of the water to the top of the ditch bank).

**free passage of water and fish**: in-stream structures constructed so as not to restrict “normal” passage of water and fish (i.e., culverts that can pass the flood flow and allow fish to move through freely).

**french drain**: see blind drain.

**freshet**: a sudden rise or overflow of a watercourse as a result of heavy rains or rapidly melting snow.

**fuel storage**: containment of gasoline or diesel fuels in stationary storages

- **mobile storage**: any containers that will be transported containing fuel, such as jerry cans, truck-box tanks
- **stationary storage**: any containers, whether above or below ground, permanently located
- **above ground storage**: fuel tanks spaced above the earth surface on a non-combustible stand, requiring spill containment, drip prevention, mechanical protection from vehicles, etc., as shown in Figure 2.2, page 2-19
- **below ground storage**: fuel tanks buried in the earth, requiring secondary containment, such as a double walled tank, leak detection, etc
- **anti-siphon device**: installed in the tank discharge line if a self closing nozzle is not used.

**gas emissions**: vapour release from fuel storage into the atmosphere due to heating of the fuel, such as from exposure to the sun

**pressure relief valve vent cap**: a device to reduce gas emission release to the atmosphere by allowing a slight pressure increase in the fuel tank prior to venting; best incorporated with tanks that are painted a light colour and/or roofed to reduce tank heat and therefore pressure buildup.

**secondary containment of fuel**: see secondary containment, and leak detection.

**self closing nozzle**: installed in the tank discharge line to prevent accidental release of fuel, such as a spring-return handle valve.

**fur farm**: farm production of fur-bearing animals.

**game farm**: [from the Game Farm Act] the land in respect of which the licensee holds a licence under the Act.

**game**: [from the Game Farm Act] fallow deer, bison and reindeer.

**gas emissions**: see fuel storage.

**gear up – throttle down**: a tractor driving technique to reduce fuel use whereby the driver reduces engine speed and shifts up a gear to maintain the same ground speed.

**geosynthetic**: man-made materials used to improve soil conditions

- **geotextile**: a man made plastics fabric used to increase the bearing capacity of soil by acting as a blanket to add reinforcement and separation; placed on the soil or subsoil to form a mat between the underlying soil and products that are placed on them, such as used under gravel at a livestock watercourse access point.

**global warming potential (GWP)**: GWP is a relative unit measured against the baseline of carbon dioxide that is a measure of the ability of a greenhouse gas to trap heat and its viable time in the atmosphere.

**grassed waterway**: a natural or constructed watercourse or outlet that is shaped or graded and planted with suitable vegetation for the purpose of dispersing surface water flow without causing erosion.
**grasslands**: important wildlife habitat and forage lands for grazing livestock; cover 1.5% of BC’s land area

**grazing area**: [from the Code under the Agricultural Waste Control Regulation] a pasture or rangeland where livestock, poultry or farmed game is primarily sustained by direct consumption of feed growing on the area

**grazing**: the consumption of standing forage (herbaceous plants) by livestock or wildlife, such as on a pasture or rangeland (also see browse)

**intensively-managed grazing**: subdivision of a grazing area into small units, with grazing periods typically less than five days; may involve an increase in stocking rates, forage utilization, labour, resources, and/or capital; results in increased production per unit area or per animal (also see livestock production)

**greenhouse effect**: the warming of the earth’s atmosphere caused by a build-up of carbon dioxide or other gases; it is believed this build-up allows sunlight to heat the earth but prevents a counterbalancing loss of heat

**greenhouse gases**: carbon dioxide, methane, nitrous oxide, that contribute to the greenhouse effect

**green manure crop**: a cover crop, often a forage species such as barley or oats, that is ploughed down into the soil late in the fall or early in the spring for to provide nutrients and organic matter to the soil

**ground level ozone**: see ozone

**groundwater**: (a) water below the level of the water table; (b) water in an aquifer (see aquifer); (c) [from the Water Act and the Code under the Agricultural Waste Control Regulation] water below the surface of the ground (editorial note: this would include soil water as well as water in the water table; see soil – soil water and water table); (d) [from the Municipal Sewage Regulation] subsurface water at or below a water table in fully saturated geologic materials and formations

**groundwater contamination potential**: the potential for contaminants to move through the soil into groundwater; influenced by risk of spills from storage or mixing areas, the absence of secondary contaminant or impermeable floors, soil characteristics and the level of the water table

**groundwater mining**: removal of groundwater exceeding recharge

**groundwater recharge**: the inflow of water to an aquifer

**recharge area**: land area over which water infiltrates to replenish an aquifer; for unconfined aquifers the area is essentially the entire land surface overlaying the aquifer; for confined aquifers the recharge area may be part of or unrelated to the overlying area (see aquifer)

**seepage area**: see seepage

**groundwater table**: see water table

**gulley**: a furrow, channel, or miniature valley, usually with steep sides through which water commonly flows during and immediately after rains or snow melt; too large for farm equipment to cross

**habitat**: the air, soil, water, food and cover components of the environment on which a plant or animal depend directly or indirectly in order to carry out their life processes such as eating, staying safe from predators, and reproducing

**connectivity**: availability of habitat for species depends on the species’ ability to move between habitat patches; keeping habitat patches connected in a corridor increases the value of habitat patches

**critical habitat**: [from the Species at Risk Act] the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species’ critical habitat in the recovery strategy or in an action plan for the species

**fish habitat**: [from the federal Fisheries Act] spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes

**wildlife habitat**: [from the Wildlife Act] the air, soil, water, food and cover components of the environment on which wildlife or species at risk depend directly or indirectly in order to carry out their life processes

**hard-surfacing**: done on outdoor areas subject to concentrated impacts, especially in high precipitation areas, such as concrete livestock yards (also see high precipitation)

**hay** and **haylage**: see livestock feed
**hazardous waste:** [from the *Hazardous Waste Regulation*] dangerous goods that are no longer used for their original purpose, as listed in the Regulation

**health hazard:** [from the *Public Health Act*](a) a condition, a thing or an activity that (i) endangers, or is likely to endanger, public health, or (ii) interferes, or is likely to interfere, with the suppression of infectious agents or hazardous agents, or (b) a prescribed condition, thing or activity, including a prescribed condition, thing or activity that (i) is associated with injury or illness, or (ii) fails to meet a prescribed standard in relation to health, injury or illness;

**heating system:** heat supply and control for a building  (also see natural heating)

**interlocked heating and ventilation system:** the controls for both heating and ventilation are combined so as to minimize energy use

**high efficiency (energy use):** lighting, heating or ventilating systems that, by their design or operation, require less energy than other similar systems (efficiency usually is the combination of all system components, including the structure, climatic conditions, controls, etc)

**high efficiency lighting:** (1) lights – the use of fluorescent, sodium, and metal halide lighting that is more efficient than incandescent lighting; (2) controls – the use of timers and motion sensors to reduce the energy needs of any lighting system

**high precipitation:** see precipitation

**holding tank:** see septic tank

**hummocking:** small-scale relief or ground disturbance characterized by raised mounds of soil; may result from trampling by large animals  (also see pugging)

**humus:** well decomposed organic matter which gives soil its dark colour and earthy smell; holds nutrients and binds mineral particles in soil

**hydraulic conductivity:** a measure of the rate at which water will move through a permeable soil or rock layer; for a particular soil or rock it may not be the same in the horizontal direction as in the vertical direction

**hydrologic cycle:** the constant circulation of water from the sea, through the atmosphere, to the land, and back to the sea by over-land, underground, and atmospheric routes

**hydrology:** the science of waters of the earth, including its properties, circulation, principles, and distribution

**impermeable:** see permeability and impervious

**impervious:** (1) a material that does not allow liquid to move through it, such as sealed concrete, roofs and hard surfaced roads  (2) a soil having a permeability not greater than $1 \times 10^{-7}$ cm per second when subjected to a head of 0.305 m of water; impervious surfaces decrease (or eliminate) infiltration and increase (or maximize) runoff

**incorporation:** mixing of fertilizers into the soil so plant roots can absorb nutrients more easily; done by tillage or by equipment placing the fertilizer in a band below the soil surface

**indoor:** enclosed and protected from precipitation and wind, such as in a building, but not a shipping container used for passive storage

**inert:** a material that does not show a chemical or biological action

**infiltration:** the downward entry of water into the Earth’s surface (usually into soil or rock); the movement of water or any liquid through the top surface layer (less than 1 cm) of the soil; the terms hydraulic conductivity, percolation, and permeability usually refer to water movement within a soil or rock layer

**injector:** a system to apply manure in bands under the soil surface rather than on top of the soil

**inorganic:** see organic

**instream crossing:** see stream crossing

**insulation:** material used to resist the flow of heat into or out of a structure, considerably more resistant than structural materials; usually in conjunction with moisture control (vapour barrier); required levels are set by building codes

**intake:** a structure or mechanism to divert water into a domestic or irrigation system

**fish screening:** a specific design to both prevent fish from being drawn into a water system (with screen openings that do not exceed 2.54 mm) and to prevent fish being forcefully drawn against the
Integrated Pest Management: (a) a management method requiring pests to be monitored in order to target pesticide applications, with the expectation that pesticide use will be reduced; (b) [Integrated Pest Management Act] decision making process that uses a combination of techniques to suppress pests and that must include but is not limited to the following elements: (i) planning and managing ecosystems to prevent organisms from becoming pests; (ii) identifying potential pest problems; (iii) monitoring populations of pests and beneficial organisms, pest damage and environmental conditions; (iv) using injury thresholds in making treatment decisions; (v) reducing pest populations to acceptable levels using strategies that may include a combination of biological, physical, cultural, mechanical, behavioural and chemical controls; (vi) evaluating the effectiveness of treatments.

Intensively-managed livestock: see livestock production.

Interceptor ditch: used to divert or redirect runoff around and away from a farm area to prevent contamination of the runoff, such as around an outdoor livestock area.

Interlocked heating and ventilation system: see heating system.

Introduce into the environment: [from the Environmental Management Act] in relation to waste includes discharge, emit, dump, abandon, spill, release and allow to escape into the environment.

Invasive pest: see pest.

Inversion: an atmospheric condition of a stable air mass where air temperature increases with an increase in altitude above the earth and stagnant air remains near the surface. (also see open burning - ventilation index)

Irrigation: the controlled withdrawal of water from an assured supply and its application as crop water to the soil to replenish water removed by evaporation, by growing plants, and by drainage below the root zone; as needed by climatic conditions.

Annual water use: the water used for irrigation during one season; given as inches of water over the crop area, or, as on a water licence, as acre-feet of water (also see acre-foot).

centre pivot irrigation: automated systems where a wheel line pivots in circle around a field.

Flood irrigation: water is turned into a field without any flow control such as furrows, boarders or corrugations. This is the least efficient, least uniform and least effective method of irrigation.

Irrigation efficiency: the ratio of the average depth of water that is beneficially used to the average depth applied, expressed as a percentage.

Irrigation gun: water is sprayed or sprinkled in high volumes through the air to the ground surface; may be used to apply liquid manure onto soil.

Irrigation interval: the average time interval between the commencement of successive irrigation on a field.

Irrigation set: the area of a field irrigated at one time.

Irrigation system uniformity: the ability of a system to apply water evenly over the crop; desirable to minimize water use and particularly important when chemigating; will vary with system design, maintenance, etc.

Irrigation water quality: see water quality.

Peak flow: the water flow rate necessary to meet the expected maximum water demand of an irrigation system.

Sprinkler irrigation: water is sprayed or sprinkled through the air to the ground surface.

Subirrigation: application of irrigation water below the ground surface by raising the water table to within or near the root zone.

Trickle irrigation: a method of microirrigation where frequent, low pressure of water is applied to the soil surface as drops or small streams through emitters at the plant location; includes tape, drip emitter or spray emitter systems.

Land: [from the Environmental Management Act] the solid part of the earth’s surface including the foreshore and land covered by water.

Leachate: (a) a product from water moving through a material, such as woodwaste, manure or soil, creating a contaminated liquid, or (b) [from the Mushroom Composting Pollution Prevention Regulation] liquid effluent including any water, precipitation or runoff.
that has come in contact with materials being
received, processed, composted or stored, or which
mixes with contaminated water generated from the
composting process or liquid which originates from
agricultural waste or the composting process; refer
to Figure 9.5, page 9-49

silage leachate: see livestock feed
woodwaste leachate: see woodwaste

leaching: the natural process by which salts and
other soluble materials are removed from soil or
other materials by percolating water; they may then
move into and through the soil (also see percolation)

leak detection: a method or system whereby a
storage facility is monitored for escape of stored
material, such as manure in semi-solid or liquid pits,
or petroleum fuel from underground tank storage

lighting: the introduction of light into a farm
structure to maintain adequate conditions for
livestock, plants or other reasons using natural or
artificial means

natural lighting: the use of natural site,
environmental and structural conditions to supply
light, such as structure orientation in a southerly
direction, the use of overhead panels, etc.

lignosulfonates: material used for dust suppression
on roads

lime: calcium carbonate, or agricultural limestone;
a soil amendment used on acid soils (pH less than 7)

livestock: domestic animals raised for breeding or
food purposes, including all farm animals and birds

livestock bedding: (a) material upon which
livestock may recline; often supplied material is
wood-based, such as sawdust or shavings, which
should be applied to soil of known C:N ratio (see
C:N); (b) area where livestock may recline;
needs to be selected considering potential impacts
to water, fish, and habitat

livestock housing: a structure, usually roofed, that
contains livestock, whether temporary or
continuously

livestock management: application of technical
principles and business methods to livestock
production

livestock access: see livestock watering

livestock feed: crop grown and harvested for
livestock

hay: dried grass or legumes harvested and stored
for livestock feed; typically less than 20 percent
moisture content

haylage: low-moisture silage; usually 40 to 50
percent moisture content

silage: green forage converted to animal feed
through fermentation; usually 65 to 70 percent
moisture content

silage leachate: normally generated from stored
silage; is a high oxygen-demanding material
which is toxic to aquatic life and must be
contained

livestock feed storage: structures design to store feed
protected from the effects of weather, especially
water; incorporate methods to control roof
stormwater, and to manage material leachate where
appropriate

silo: structure for storing silage or haylage; may
be a vertical cylinder, or a horizontal trench or
bunker

livestock production: the business of producing
livestock

extensive grazing livestock: providing a pasture
or grazing area large enough to supply all the
animals nutrient requirements

intensive grazing livestock: providing
supplemental feed to animals in addition to the
feed on a pasture or grazing area as the area does
not supply all the animals nutrient requirements

intensively-managed livestock: where significant
management is required for both livestock
production and environmental protection

livestock watering: either in-stream or off-stream
systems to supply livestock water

livestock water development: a new or
improved source of water, such as a well, spring,
or pond, together with a storage and delivery
system

in-stream watering: a system where livestock
access a watercourse directly, sometime with
restricted or managed access locations

off-stream watering: a system where livestock
are provided water, usually by pipe and water
trough located back from the watercourse, that
reduces impacts to the watercourse

managed access: the duration, timing and
intensity of livestock access to a watercourse is
controlled to minimize the impact on water
quality and riparian area health
**low precipitation**: see soil-based yards

**low livestock density**: see soil-based yards

**lure crops**: crops such as cereal grains or vegetables which are planted on lands surrounding a specific area where wildlife or waterfowl tend to congregate; grown as a sacrifice crop to try to distract the wildlife away from cash crop area

**manure storage**: [from the Code under the Agricultural Waste Control Regulation, item 4] on-farm agriculture waste must be produced or used on that farm

**manure storage facility**: [from the Code under the Agricultural Waste Control Regulation] includes a structure, reservoir, lagoon, cistern, gutter, tank or bermed area for containing agricultural waste prior to its use or disposal, but does not include a vehicle or any mobile equipment used for transportation or disposal of agricultural waste

**covered storage**: [from the Code under the Agricultural Waste Control Regulation] field storage must be covered (from Oct 1st to April 1st) in areas that receive more than 600 mm precipitation from October to April inclusive

**earthen storage**: a structure constructed primarily of natural geological materials, usually for liquid manure storage

**escape of waste**: [from the Code under the Agricultural Waste Control Regulation – item 6] requires a storage facility containing agricultural waste must prevent the escape of waste that causes pollution (also see leak detection)

**field storage**: [from the Code under the Agricultural Waste Control Regulation] a temporary stock of agricultural waste (solid manure) ready to be drawn upon for use as a crop fertilizer or soil conditioner

**field storage – “short term”**: [from the Code under the Agricultural Waste Control Regulation – item 8] solid manure may be stored on a field for 2 weeks or less, if used within 2 weeks and stored to prevent pollution

**field storage – “long term”**: [from the Code under the Agricultural Waste Control Regulation item 8] solid manure may be stored on a field for up to 9 months (with conditions)

**secondary containment**: a facility that prevents manure loss into the environment in the case that the primary containment facility fails

**structurally sound**: manure storage built to specifications that prevent manure loss or structural failure

**sufficient capacity**: capacity to store waste produced or used on a farm for the period of time needed to allow for either the application as a fertilizer or soil conditioner or its removal

**marine plant**: [from the federal Fisheries Act] includes all benthic and detached algae, marine flowering plants, brown algae, red algae, green algae and phytoplankton

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**MOE**: Ministry of Environment

**MOE-approved/permitted landfill**: a disposal site, whether on or off farm, that has been approved and or permitted by the MOE for use as disposal of defined wastes

**macropore**: the large pores responsible for rapid water movement in soil; usually greater than 0.1 mm diameter

**manage**: (a) to have under effective control; (b) to use to the best advantage

**managed access**: see livestock watering

**manure**: animal feces and urine, plus materials such as bedding and waste water

**manure, liquid**: has very low solid content and flows freely (cannot be piled)

**manure, semi-solid**: has a solid content of less than 20% but does not flow freely as liquid manure

**manure, solid**: has a solid content of 20% or more and retains its shape when piled

**manure spreading**: application of manure onto crop land according to its nutrient content; should be part of a Nutrient Management Plan (also see Nutrient Management Plan)

**manure handling**: the agitation, movement or transport of manure within the farm site or between storage or treatment locations

**manure testing**: laboratory analysis of a sample of manure for dry matter, nitrogen, phosphorous, potash, and other nutrients; a part of a Nutrient Management Plan (also see Nutrient Management Plan)

**manure used as a fertilizer**: application of manure according to its fertilizer value (also see fertilizer)

**manure storage**: [from the Code under the Agricultural Waste Control Regulation, item 4] on-farm agriculture waste must be produced or used on that farm

**manure storage facility**: [from the Code under the Agricultural Waste Control Regulation] includes a structure, reservoir, lagoon, cistern, gutter, tank or bermed area for containing agricultural waste prior to its use or disposal, but does not include a vehicle or any mobile equipment used for transportation or disposal of agricultural waste

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**secondary containment**: a facility that prevents manure loss into the environment in the case that the primary containment facility fails

**structurally sound**: manure storage built to specifications that prevent manure loss or structural failure

**sufficient capacity**: capacity to store waste produced or used on a farm for the period of time needed to allow for either the application as a fertilizer or soil conditioner or its removal

**marine plant**: [from the federal Fisheries Act] includes all benthic and detached algae, marine flowering plants, brown algae, red algae, green algae and phytoplankton
meanders: where a stream flows from side-to-side creating loops, bends and curves (also see sinuosity)

metals: chemical elements which are usually found in small amounts in soil, some of which are required in trace amounts to plants (micronutrients), but can become toxic to plants, animals and soil biology; examples are arsenic, cadmium and lead

methane (CH$_4$): a greenhouse gas that is produced during anaerobic decomposition of organic wastes such as manure.

micronutrients: chemical elements that are necessary in only trace amounts (usually less than 1 ug/mL in plants) for the growth of plants; examples are boron, copper, iron, zinc

milkhouse waste: waste from the milking process, including manure, spilled milk, udder washings, and equipment wash water containing detergents, acids and chlorine

minimum tillage: see tillage

mitigation: projects, actions and management practices that result in a reduction of greenhouse gas emissions from farms and agri-food activities

monitoring: the process of checking, observing, or keeping track of something for as specified period of time, or at specified intervals

mortality: livestock loss due to death

mass mortality: livestock losses exceeding normal death loss, usually due to uncontrollable circumstances such as disease, vandalism, loss of electrical power, etc; requires a response contingency plan (also see contingency plan)

mortality record: a record of the location, amount and type of material in on-farm mortality pits

mortality disposal: methods to properly dispose of livestock based on the cause of death, as outlined in Table 3.4, page 3-32

burying: burial in pits used on small and large animals; considered the least preferred method for disposal

mortality composting: used on small animals; may be also used on large animals

mortality incinerator: used on small animals; [from the Code under the Agricultural Waste Control Regulation] emissions not to exceed 180 mg per cubic metre of particulate matter and 20% opacity, with exceptions; refer to page 274 (also see opacity)

natural disposal: wildlife consumption of mortalities; normally the least preferred method; used only in appropriate areas of BC and those remote from neighbours

secondary users: rendering plants

mulch: a protective covering spread or left on the ground to reduce evaporation, maintain even soil temperature, prevent erosion, control weeds or enrich the soil; such as leaves or woodwaste

mushroom compost: [from the Mushroom Composting Pollution Prevention Regulation] a growing medium for mushrooms produced through the biological decomposition of organic materials under controlled circumstances

mushroom media: the growing material for mushrooms, produced from composting

fresh media: ready-to-use media from composting

spent media: the growing material after a mushroom crop has been harvested, having no further production potential; is subsequently applied to land as a soil conditioner

Mycorrhizae fungi: a beneficial soil fungus well known to facilitate phosphorus absorption in corn and many other crops

native species: [from the BC Wildlife Amendment Act 2004] a species that is (a) indigenous to BC, or (b) has extended its range into BC from another part of North America, unless the species was introduced by human intervention or activities, or any part of the extension of its range within North America was aided by human intervention or activities. Native species refer to species that naturally occur in an area, such as antelope sage brush in the Okanagan. Native species include plants and animals

natural flow: see stream

natural stream: watercourses that have not been significantly altered by human activity and are predominantly in their natural state.

natural heating: heat derived from natural sources, such as earth heat or solar heat, including equipment, controls, etc; for a building, water trough, etc
**nitrogen**: a primary plant nutrient; taken up by plants primarily as nitrate (NO$_3^-$) or ammonium (NH$_4^+$)

**inorganic nitrogen – ammonium (NH$_4^+$)**: common form used by plants; is soluble and found in the liquid fraction of soil

**inorganic nitrogen – ammonia (NH$_3$)**: a transitional form of ammonium, easily volatized into the air

**inorganic nitrogen – nitrate (NO$_3^-$) and nitrite (NO$_2^-$)**: nitrite is an unstable transitional form of nitrate; nitrate does not generally bind to soil particles and is therefore prone to leaching; both can be toxic to fish

**organic nitrogen**: most of nitrogen in soil (98%) is tied up in organic matter and unavailable to plants

**denitrification**: the removal of oxygen by soil bacteria that converts nitrogen to a gas; nitrate nitrogen (NO$_3^-$) is changed to nitrite (NO$_2^-$) and then to gases, nitrous oxide (N$_2$O), nitric oxide (NO), and nitrogen (N$_2$); occurs under anaerobic conditions caused by excessive moisture and/or soil compaction; nitrogen may be lost from the soil to the atmosphere

**nitrification**: the oxidation (process of combining with oxygen) of ammonium (NH$_4^+$) to nitrite (NO$_2^-$) and then to nitrate nitrogen (NO$_3^-$) in soil by soil bacteria; occurs readily under conditions of warm temperatures, adequate oxygen and moisture, and optimum pH; a vital process in providing nitrogen for plant growth

**nitrogen cycle**: the continuous recycling of nitrogen in the environment, as shown in Figure 8.1, page 8-4

**nitrogen fixation**: the process of nitrogen combining with oxygen and hydrogen; is necessary in order for plants to utilize nitrogen; may be fixed by various soil organisms; the fertilizer industry fixes nitrogen in manufacturing nitrogen fertilizers

**nitrogen oxides (NO$_x$)**: air contaminants that contribute to the production of ground level ozone which results in adverse health effects, negatively impacts crop growth and can contribute to acid rain production

**nitrous oxide (N$_2$O)**: a greenhouse gas produced in the soil from the biochemical reduction of nitrate nitrogen to gaseous nitrogen compounds

**Normal Farm Practice**: [from Farm Practices Protection (Right to Farm) Act] means a practice that is conducted by a farm business in a manner consistent with (a) proper and accepted customs and standards as established and followed by similar farm businesses under similar circumstances, and (b) any standards prescribed by the Lieutenant Governor in Council, and includes a practice that makes use of innovative technology in a manner consistent with proper advanced farm management practices and with any standards prescribed under paragraph (b).

**noxious weed**: [from Weed Control Act] a weed designated by regulation to be a noxious weed, and includes the seeds of the noxious weed; specified in Weed Control Regulation, Schedule A

**nuisance**: a source of annoyance, such as noise, odour or dust

**nursery**: production of young plants for transplanting

**container nursery**: nursery plants grown in containers

**Nutrient Management Plan**: a technical process that optimizes the relationship between land-based application of nutrients, farm management techniques, crop requirements and land use to maximize on site nutrient use and minimize environmental impact; the process attempts to balance nutrients on an individual crop or field basis as well as on a whole farm basis; refer to page 6-11

**nutrient**: (a) a chemical element that is essential for growth, development or reproduction of living organisms (i.e., plants, animals); (b) as a pollutant, any element or compound that fuels abnormally high organic growth in aquatic ecosystems, such as nitrogen or phosphorous causing eutrophication of a lake (also see plant nutrients)

**nutrient applicator calibration**: a detailed method of ensuring nutrient application is uniform and in appropriate amount

**nutrient cycle**: the movement of nutrients from plants to animals and back, such as the growth of forage which is grazed by livestock whose manure is spread onto the forage land for crop growth

**non-agricultural waste**: waste generated by a non-agricultural operation
odour: the term used to describe the effect of various substances on the human olfactory system. Odours are generally characterized using the four basic parameters of detectability, quality, intensity, and acceptability.

off-farm: any activity, construction or practice that occurs on land other than a farm.

on-farm: any activity, construction or practice that occurs on land of a farm, either at a farmstead site or at farm fields.

direct farm sales: sale of farm products directly to the consumer on-farm.

on-farm processing: processing of farm products, such as washing, grading, packaging, or processing to increase product value, such as making wine or ice cream.

opacity: the degree to which a discharge of an air contaminant reduces the passage of light or obscures the view of a background object; expressed as zero percent (transparent) to 100 percent (opaque).

open fires: as regulated by the Wildfire Act; within 1 km of forest land or grass land (as outlined in Appendix A, page A-15) (see also outdoor burning).

Danger Region: three provincial regions (Wildfire Regulation, Schedule 1).

Fire Danger Class: five classes depending on the Buildup Index and the Fire Weather Index (Wildfire Regulation, Schedule 2).

Buildup Index: [from Wildfire Regulation] five levels the same as in the Canadian Forest Fire Weather Index System (Canadian Forest Service).

Fire Weather Index: [from Wildfire Regulation] three provincial regions as defined in the Canadian Forest Fire Weather Index System (Canadian Forest Service).

Restrictions on High Risk Activities: requirements regarding the top three Fire Danger Classes (Wildfire Regulation, Schedule 3).

organic: (a) referring to, or derived from, living organisms; (b) in chemistry, any compound containing carbon.

inorganic: matter other than plant or animal, and not containing a combination of carbon/hydrogen/oxygen as in living things.

organic matter: (1) [from Organic Matter Recycling Regulation] those materials, other than agricultural wastes, set out in Schedule 12 that are suitable for composting; (2) plant residues, humus (stable organic matter), and soil life (also see soil organic matter).

organic soil subsidence: a gradual lowering of the surface elevation of an organic muck soil, or a reduction in the thickness of organic matter. The organic matter is lost or broken down in a number of ways: wind erosion, water erosion, biological oxidation (drainage and tillage add air to the soil, speeding the degradation of organic materials by aerobic bacteria).

organism: a living thing.

outdoor burning: [from Open Burning Smoke Control Regulation] the combustion of material with or without control of the combustion air and without a stack or chimney to vent the emitted products of combustion to the atmosphere (see also open fires).

smoke: the gases, particulate matter and products of combustion emitted into the atmosphere when debris is open burned.

ventilation index: a measure of the ability of the atmosphere to vent or disperse smoke or other particulates: 0-33 is poor; 34-54 is fair; 55-100 is good (see inversion) - for more information go to http://www.weatheroffice.pyr.ec.gc.ca/wxhealth/smoke/default_e.html.

outdoor livestock area: see confined livestock area, seasonal feeding area, and grazing area.

overland flow: water that moves over the land surface (see also runoff).

concentrated flow: surface water flow that accumulates or converges into well-defined channels; influenced by soil and soil cover; depending on the grade (water velocity) may lead to soil erosion.

sheet flow: surface water flow that is spread out like a sheet on the land.

overwintering: see seasonal feeding area.

oxygen demand: the need for oxygen to meet the needs of biological and chemical processes in water.

BOD or biological oxygen demand: a measure of dissolved oxygen required by microorganisms in the biochemical oxidation of organic matter, such as wastes in water (also see dissolved oxygen).
**ozone**: a form of oxygen with a sharp smell

**ground level ozone**: formed in the presence of sunlight by reactions between nitrogen oxides and volatile organic; ground level ozone is a pollutant that along with other substances forms smog and can be harmful to plant, animal and human health

**ozone depleting substance**: a substance listed in Class I or Class II of Schedule A of the *Ozone Depleting Substances and Other Halocarbons Regulation*

**ozonosphere**: also known as ‘the ozone layer’; the atmospheric region about 40 km above Earth characterized by a high ozone content; is affected by ozone depleting substances

**paddock**: an outdoor livestock area; may be either a confined livestock area (horse paddock) or a grazing area (pasture)

**pasture**: (a) a grazing area enclosed and separated from other areas by fencing or other barriers; (b) the management unit for grazing land

**intensively-managed pasture**: forage production is maximized with fertilizer and irrigation, as required, for continuous livestock grazing during the crop growing season

**particulates**: solid particles in the atmosphere either formed in the air by reactions among gases or injected into the air by processes on the ground. (for particulates in water see *suspended solids*)

**parts per million**: the number of “parts” by weight of a substance per million parts of water (written as ppm); used to represent pollutant concentrations

**pathogen**: an organism capable of causing disease in humans, animals or plants

**peak flow**: see irrigation and *stormwater management*

**percent slope**: the rise in land (vertical distance from the horizontal) divided by the run (horizontal distance) expressed as a percentage; e.g., a 5% slope would be a 5 m rise over 100 m length

**percolation**: the downward movement of water through layers of soil, rock or other material

**perennial**: a plant that lives for more than two years

**perimeter drain**: a piping system to carry clean roof water and soil moisture away from a building foundation, for structural-integrity purposes

**MOE-approved dye**: such as a water soluble disodium salt of fluorescein, used to test if water flow is connected between “clean” drains and “dirty” drains

**permeability**: a measure of the relative ease with which water will move through soil or rock

**impermeable**: see *impervious*

**Pest Management Plan**: [from the *Pesticide Control Act*] a plan that describes (a) a program for controlling pests or reducing pest damage using integrated pest management, and (b) the methods of handling, preparing, mixing, applying and otherwise using pesticides within the program

**pest**: [from the *Integrated Pest Management Act*] an injurious, noxious or troublesome living organism, but does not include a virus, bacteria, fungus or internal parasite that exists on humans or animals (also see *weed*)

**exotic pest**: non-native species of pests

**invasive organism**: species that were absent in undisturbed portions of the original landscape, such as invasive plants that will invade or increase following disturbance or continuous heavy grazing of the native plants

**pest record**: a record of pest monitoring and of the control methods used on-farm

**pesticide**: (a) any material used to kill, control or manage pests, including products to manage the growth of plants; (b) [from the *Integrated Pest Management Act*] a micro-organism or material that is represented, sold, used or intended to be used to prevent, destroy, repel or mitigate a pest, and includes (i) a plant growth regulator, plant defoliator or plant desiccant, (ii) a control product under the *Pest Control Products Act* (Canada), other than a device that is a control product, and (iii) a substance that is classified as a pesticide by regulation

**pesticide application equipment calibration**: a four step process of ensuring that pesticide application is uniform and at the appropriate rate; the steps are setting up the equipment, measuring the delivery rate, adjusting delivery rate, and for sprayers, calculating how much pesticide to add to the tank; refer to Equipment Calibration, page 5-16
pesticide applicator certificate: (a) [from the Integrated Pest Management Act] a certificate issued to a person who has passed an examination, set by the administrator, in the appropriate applicator category; (b) required for purchase and use of certain pesticides, as listed in Crop Production Guides, as shown on page 5-6

pesticide application record: a record of all pesticide applications including the site, date, pesticide and amount used, crop stage, harvest date, application method, spray volume, weather observations, and precautions followed (eg. Buffer zones)

pesticide groupings: pesticides are grouped in four ways; according to (1) the pest they control (fungicides, herbicides, insecticides, miticides, nematicides, rodenticides, molluscicides), (2) the way they enter or affect the target pest (contact or systemic), (3) their chemical structure grouping, (4) resistance management

pesticide resistance: a build-up of immunity to a pesticide, usually due to overuse or appropriate use over an extended period

Pesticide Use Permit: permit required under the Pesticide Control Act for application of pesticide to public lands, private land used for forestry, transportation or public utilities

rinsing pesticide containers: see rinsing method

pH: the numeric value that describes the intensity of the acid or alkaline condition of a substance; a scale range of 0 to 14, where 7 is neutral, less than 7 is acidic, more than 7 is alkaline

phosphorus: a primary plant nutrient; is absorbed by plants depending upon soil pH

phosphorous sensitive area: where surface water flows to a lake or pond; suggested farms with soils greater than 80ug/mL have a Nutrient Management Plan (also see Nutrient Management Plan)

photosynthesis: the manufacture by plants of carbohydrates and oxygen from carbon dioxide and water in the presence of chlorophyll, using sunlight as an energy source

pitless adaptor: see well casing

plant age mix: see range health

plant nutrients: chemical elements required for plant growth; carbon/hydrogen/oxygen, taken primarily from the air or water, plus others divided into three groups (primary, secondary, micronutrients), normally absorbed from the soil by plant roots

carbon/hydrogen/oxygen: basic plant life building blocks

primary plant nutrients: nitrogen, phosphorous, potassium

secondary plant nutrients: calcium, magnesium, sulphur

micronutrients: iron, manganese, boron, chlorine, zinc, copper, molybdenum

plough pan: a compacted layer, restricting root and water movement, which may form in some soils just below the tilled area after several years of primary tillage to the same depth (also see tillage)

point bar: collection of deposited slit, soil, and gravel found on the inside of meanders in a stream

point of diversion: see diversion

pollutant: material which causes harm to organisms directly or to their environment

pollution: [from the Environmental Management Act] the presence in the environment of substances or contaminates that substantially alter or impair the usefulness of the environment (also see contamination and deleterious substance)

non-point source: pollution discharged over a wide land area with no well-defined source, such as erosion from disturbed soil; may be difficult to identify and control

point source: pollution discharged from a well-defined location, such as a pipe

porosity: the percentage of the volume of a material that is occupied by pore spaces; is an indication of the capacity of the material to hold water

potassium: a primary plant nutrient

potable water quality: see water quality

potential contaminant: see contaminant

precipitation: (1) [from the Organic Matter Recycling Regulation] as determined by the Canadian Atmospheric Environmental Service Reports of Environment Canada; (2) the process by which water vapour condenses in the atmosphere or
onto a land surface in the form of rain, hail, sleet or snow.

**High precipitation:** greater than 600 mm precipitation October 1st to April 30th inclusive

**Low precipitation:** less than 600 mm precipitation October 1st to April 30th inclusive

**Pressure relief valve vent cap:** see fuel storage

**Probable source of contamination:** see well

**Problem wildlife:** see wildlife

**Productive conservation:** see conservation

**Pugging:** tracks of large animals left in soft soil; wet clayey or silty soil has the consistency to hold pug marks; upon drying, pugged areas have a honeycombed appearance and a hard, dry, irregular surface difficult to walk across (also see hummocking)

**Puddled soil:** dense, massive soil artificially compacted when wet and having no aggregated structure. The condition commonly results from the tillage of a fine-textured or clayey soil when it is wet

**Range** or **Rangeland:** land supporting vegetation that is grazed or that has the potential to be grazed, and is managed as a natural ecosystem

**Forested range:** woodlands having understory vegetation suitable for grazing

**Grassland range:** lands on which the vegetation is dominated by grasses, grass-like plants, or forbs

**Range health:** on a site, the combination of the plant community, the layers of plants present, the moisture retention, soil erosion and invasive plants present

**Plant age mix:** the type, amount and age of plants at a site; a range health indicator

**Rangeland:** land on which the native vegetation is predominately grasses, grass-like plants, forbs, or shrubs

**Rangeland holding area:** [from the Code under the Agricultural Waste Control Regulation, Section 28] confined livestock areas where livestock are moved to prior to being released onto a grazing area, that when held there for no longer than 72 hours, are allowed access to a watercourse (with conditions)

**Reach:** length of a stream with similar characteristics, selected for study or observation

**Receiving waters:** watercourses that receive stormwater, runoff, or wastewater discharges

**Recharge:** see groundwater

**Reclaimed water:** [from the Municipal Sewage Regulation] effluent from a sewage facility that is suitable for a direct designated water use or a controlled use

**Refuse:** [from the Environmental Management Act] discarded or abandoned materials, substances or objects

**Refuse disposal site:** a site selected, planned and managed in such a way to receive farm refuse in an environmentally sound manner

**Refuse records:** a record of the location, amount and type of material in on-farm refuse sites

**Renewable resource:** natural resource which can be re-established mainly because of its ability to reproduce, such as trees or animals, or water, due to the water cycle

**Reservoir:** a water impoundment requiring a constructed dam, such an artificial lake, pond or basin used for the storage, regulation and control of water, silt, debris and other liquid or liquid-carried material (also see dugout)

**Residue:** see crop production

**Return period:** the frequency of occurrence of a hydrologic event whose intensity and duration can be expected to be equalled or exceeded; usually expressed in years, such as “the reservoir will fill four years in five”

**Reuse and Recycle:**

**Reuse of farm waste:** the first step in using waste, this is a process where a waste is used again for its original purpose or for a purpose similar to the original, such as silage bags reused as tarps to cover hay

**Recycle of farm waste:** the second step in using wastes, this is a process where a waste can no longer be used for its original or similar purpose but is reprocessed into a new product, such as metal equipment parts being recycled as scrap iron
**recyclable material**: [from the *Environmental Management Act*] a product or substance that has been diverted from disposal, has no reuse value in its present form and satisfies at least one of the following criteria: (a) is organic material that has been diverted from residential, commercial or institutional sources and is capable of being composted, or is being composted, at a site; (b) is managed as a marketable commodity with an established market by the owner or operator of a site; (c) is being used in the manufacture of a new product that has an established market or is being processed as an intermediate stage of an existing manufacturing process; (d) has been identified as a recyclable material in a plan.

**revetment**: installation of materials such as trees, boards, etc., that dissipate or deflect a stream’s energy protecting stream banks from erosion.

**right of way**: includes (a) an easement, (b) a statutory right of way, and (c) a limited interest in the land or a licence or a permit that grants the right to construct, operate or maintain works of a lineal nature on, over or under land.

**rill**: see erosion.

**rinsing method**: a requirement of the *Hazardous Waste Regulation* for empty pesticide containers as outlined in Table 5.2, page 5-12.

**pressure rinse**: [from the *Hazardous Waste Regulation*] to clean by means of pressurized spraying of an appropriate solvent into an empty container for at least 30 seconds so that all interior surfaces of the container are rinsed.

**rinse**: [from the *Hazardous Waste Regulation*] to introduce an appropriate solvent into an empty container in an amount not less than 20% of its volume, to close and shake the container so that the solvent makes contact with all interior surfaces, and to open and empty the container.

**triple rinse**: a prescribed rinse method for glass pesticide containers.

**riparian, area or zone**: (a) transition area between watercourses and the surrounding, usually drier, upland areas, (b) the area of land that is adjacent to a stream, river, lake, or wetland, and contains vegetation that, due to the presence of water, is distinctly different from the vegetation of adjacent upland; in dry locations, is easily identified by the green vegetation in contrast to the browns and yellows of the drier uplands.

**riparian continuity**: where riparian vegetation is uninterrupted by gaps, breaks, or areas of bare ground.

**riparian vegetation**: plant communities dependent upon the presence of free water near the ground surface (high water table).

**riparian condition**: an assessment of condition leads to an evaluation of riparian health; three levels of functioning condition are:

- **proper functioning condition**: healthy riparian areas with the most stable, non-eroding lands and the best fish habitat.
- **functional at risk**: areas that are lacking in some healthy features, and will experience some stream bank erosion and lowering of the water table and fish habitat at risk.
- **non-functional**: areas that have few if any healthy features, and which are most likely to have highly eroding banks, and which over time will experience channel deepening and subsequent lowering of the water table and poor fish habitat.

**river**: a stream of water of substantial volume (also see stream).

**roads**: farm access used for normal farm operation.

- **critical slope**: except for short lengths, road grade or slope should not exceed 10 percent (1 m fall in 10 m length) to reduce soil erosion.
- **natural contours**: where possible to construct, a road using the existing land contour (along a slope) is preferred over one crossing contours (up or down a slope) to reduce soil erosion, etc.

**rockwool**: an inert, non-polluting, non-degradable spun-rock fiber manufactured from lava rock; used as a soilless rooting media in hydroponic greenhouse systems and nursery crops.

**root zone**: depth of soil that plant roots readily penetrate and in which the predominant root activity occurs.

**runoff**: also called overland flow; it is the portion of rainfall precipitation (stormwater), snow melt, or irrigation water that moves across the land as surface water flow; occurs when the stormwater amount, snow melt, or irrigation application rate, exceeds the soil infiltration rate, or from the surfacing of subsurface flows before they reach a receiving watercourse or a defined drainage channel.
**runoff filtration**: standing crops and crop residues decrease water velocities resulting in fewer suspended solids and dissolved chemicals being carried by runoff water

**runoff storage**: containment of runoff (to prevent its entry into groundwater or watercourses) until proper disposal can be done; usually contains little solid material

**stormwater**: one source of runoff (see stormwater)

**yard runoff**: runoff from livestock yards, possibly containing manure or other contaminants

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**seasonal feeding area**: [from the Code under the Agricultural Waste Control Regulation] an area (a) used for forage or other crop production, and (b) used seasonally for feeding livestock, poultry or farmed game that is primarily sustained by supplemental feed, but does not include a confined livestock area or grazing area

**seasonal feeding location**: the site within a seasonal feeding area where feeding is actually occurring, usually during the non-crop growing season, often in winter; these sites must be moved through the entire area to ensure manure is properly distributed for the following years’ crop needs (note that manure spreading in winter is otherwise not recommended)

**free range**: an outdoor seasonal feeding area used by poultry

**overwintering**: a seasonal feeding area used during the non-growing season to feed livestock

**perennial versus annual crop**: considerations that must be made when managing a seasonal feeding area; some such areas on annual crop land may be characterized as confined livestock areas and must be managed as such

**secondary containment**: a system whereby leakage from, or failure of, a storage facility, piping system, etc., is prevented from escape into the environment; may be a requirement or a beneficial practice for materials that are potential contaminants

**liquid manure secondary containment**: (a) a method of capturing leaks while in storage; (b) when piped near a watercourse, a second, larger diameter pipe enclosing the manure pipe to collect and direct leaks away from the watercourse

**petroleum secondary containment**: double-walled tank used for an above- or below-ground storage, or impervious curb and floor under above-ground tanks

**seepage**: the infiltration and percolation of surface water from overland flow, ditches, channels, or other watercourses

**seepage area**: a surface area that frequently emits groundwater; it is usually found at the upper contact between a lower impermeable layer and an upper permeable layer

**sediment**: undissolved soil particles, sand and minerals washed from the land into watercourses as a result of natural and human activities; will give water a cloudy appearance

**sediment load**: the amount of sediment carried by running water or wind

**self closing nozzle**: see fuel storage

**sensitive area**: an area on or near a farm that may need to be protected from an unreasonable adverse affect caused by a farm activity; the sensitive area may be an area identified as wildlife habitat, habitat of a specific species recognized for its biodiversity value, human dwellings and activity areas, non target crops in the case of pesticides and nutrient application, or aquatic and riparian areas

**septic field**: the part of a sewage system that receives the septic tank discharge and disposes of it (also see sewerage system)

**septic tank**: [from the Sewerage System Regulation] a water tight container for receiving, treating and settling domestic sewage (also see sewerage system)

**holding tank**: [from the Sewerage System Regulation] a water tight container for holding domestic sewage until the domestic sewage is removed for treatment

**septic tank maintenance**: the periodic removal (usually every 3 to 5 years) of accumulated solids from a septic tank to prevent their moving to the septic adsorption field, thus maintaining the effectiveness and extending the life of the field

**set-a-side**: an area of cultivated land which has been seeded to a mixed stand of perennial grass and legume forage species; the land is left unharvested for a period of 1 to 5 years specifically for the benefits of soil conservation and wildlife habitat

**setback**: a practice whereby a farm structure is located or a farm practice is done allowing for a
separation distance from a sensitive area appropriate to the environmental risk involved

**building setback**: a distance set as a guideline to reduce risks to a watercourse from a farm building, usually chosen based upon the type of watercourse

**sewerage system**: [from the Sewerage System Regulation] a system for treating domestic sewage that uses one or more treatment methods and a discharge area, but does not include a holding tank or privy(also see septic tank and septic field)

**sheet flow**: see overland flow

**shelterbelt**: windbreak of living trees and shrubs established and maintained for protection of farm lands or buildings

**shrub**: woody plants that are usually multi-stemmed

**silage**: see livestock feed

**siltation**: the accumulation of sediments on the bottom of watercourses

**sinuosity**: the amount of curvature in a stream channel (also see meanders)

**sleighfoot**: a system to apply manure in bands on the soil surface underneath a grass canopy

**slope**: a slant or incline of the land surface, measured in degrees from the horizontal, or in percent (change in elevation per 100 of the same units of horizontal distance)

**soil**: a mixture of living organisms (such as bacteria, fungi, plant roots), mineral particles, water, air, and dead organic matter; includes the entire mantle of unconsolidated material above bedrock; provides nutrients, moisture, and anchorage for land plants

**soil aggregates**: a group of soil particles held by cohesion, in such a way that they behave as a unit

**soil amendments**: includes all materials managed to provide nutrients for crops (fertilizers) and/or all materials managed for their beneficial impact on the biological, physical or chemical nature of the soil (soil conditioners)

**soil buffering capacity**: the ability of soil to resist a change in its pH

**soil cultivation**: tillage to prepare land for seeding or transplanting and later to control weeds and loosen the soil

**soil compaction**: the loss of pore structure and aggregate stability with soil, caused by traffic and tillage, particularly in wet soil; reduces the movement of water, air, nutrients and soil microbes in soil

**soil conditioner**: (1) [from the Organic Matter Recycling Regulation] (a) managed organic matter that measurably improves specific chemical or physical characteristics of soil or chemical or physical processes for a given use, or (b) a plant growth medium; (2) materials that contain limited amounts of nutrient, but are managed for their beneficial impact on the biological, physical or chemical nature of the soil, but not managed as fertilizer (also see fertilizer)

**soil conditioner versus fertilizer**: materials that have properties that allow them to be used as both a fertilizer and a soil conditioner should be managed as a fertilizer; see Tables 6.4 and 6.5, pages 6-6 and 6-7

**soil moisture**: see soil water

**soilless medium**: [from the Code under the Agricultural Waste Control Regulation] a material that is manufactured for the growing of plants and may contain natural soils

**soil organic matter**: organic matter that has become part of the humus portion of the soil (not crop residue or organic matter on the soil surface)

**soil quality**: a measure of soil health, having adequate pore space and nutrients, high level of organic matter, good drainage, and an active soil life (such as earthworms, fungi, bacteria)

**soil salinity**: the relative amount of soluble salts present in the soil expressed in terms of percentage, parts per million, or dS/m; salt in excess can have negative impacts on soil quality and crop production; see electrical conductivity

**soil structure**: the way groups of soil particles (aggregates) are grouped together; a soil that has lots of small aggregates, lots of pore space, and does not crust, has good soil structure

**soil texture**: the relative portions of clay, sand or silt (the mineral particles) in a soil; described as “sandy loam”, “silty clay”, etc.

**soil water**: water in the soil above the water table (also see water table)

**soil fumigation**: pesticide application to the soil to control soil borne pests such as nematodes
soil-based yard: a confined livestock area where livestock use and climatic conditions do not require hard-surfaced yards; is best suited to sites that have both of the following (refer to Worksheet #1, page 44) (also see confined livestock area):

- low precipitation: see precipitation
- low livestock density: areas of 2 m² or greater per 100 kg of livestock for day use, or 6 m² or greater per 100 kg of livestock for continuous use

special management areas: areas along agricultural land boundaries with residential or other areas that have restricted farming practices so as to reduce neighbour conflicts

special waste: see hazardous waste

species: [from the Wildlife Amendment Act 2004] a species, sub-species, variety or geographically or genetically distinct population of (a) animals, (b) fish, (c) plants, or (d) other organisms, except bacteria and viruses

aquatic species: [from the Species at Risk Act] a wildlife species that is a fish or a marine plant, as defined in the federal Fisheries Act (see fish, and see marine plant)

endangered species: [from the Species at Risk Act] means a wildlife species that is facing imminent extirpation or extinction [from the Wildlife Amendment Act 2004] means a species designated by regulation under section 6(2) or (4) as an endangered species

extirpated species: [from the Species at Risk Act] a wildlife species that no longer exists in the wild in Canada, but exists elsewhere in the wild [from the Wildlife Amendment Act 2004] means a species designated by regulation under section 6(1) as an extirpated species

native species: [from the Wildlife Amendment Act 2004] a species that (a) is indigenous to BC, (b) has extended its range into BC from another part of North America, unless (i) the species was introduced to North America by human intervention or activities, or (ii) any part of the extension of its range within North America was aided by human intervention or activities

species at risk: [from the Species at Risk Act] an extirpated, endangered or threatened species or a species of special concern; listed in the Act

species of special concern: [from the Species at Risk Act] a wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats

threatened species: [from the Species at Risk Act] a wildlife species that is likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction [from the Wildlife Amendment Act 2004] means a species designated by regulation under section 6(2) or (4) as an endangered species

wildlife species: [from the Species at Risk Act] a species, subspecies, variety or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and (a) is native to Canada; or (b) has extended its range into Canada without human intervention and has been present in Canada for at least 50 years

specified risk material (SRM): the tissues of ruminant animals that are of highest risk of transmitting bovine spongiform encephalopathy (BSE)

spent mushroom media: see mushroom media

spill: (a) [from the Environmental Management Act] the introduction of a substance into the environment, whether intentional or unintentional, otherwise than as authorized under this Act; (b) [from the Spill Reporting Regulation] release or discharge, except as authorized or allowed, into the environment of a substance in an amount equal to or greater than the amount listed in column 2 of the Schedule of this Regulation for that substance

fertilizer spill: [from the Spill Reporting Regulation] amounts exceeding 50 kg or 50 litres must be reported

manure spill: [from the Spill Reporting Regulation] any polluting substance in amounts exceeding 200 kg or 200 litres must be reported

pesticide spill: [from the Spill Reporting Regulation] amounts exceeding 5 kg or 5 litres must be reported

petroleum spill: [from the Spill Reporting Regulation] amounts exceeding 100 litres must be reported

spinning discs: a system to apply manure onto soil that uses spinning discs to throw and spread the manure

splash plate: a system to apply manure on the soil surface by having pumped manure hit an inclined plate causing the manure to spread out in a fan shape
**spoil bank**: excavated soil piled along a canal or ditch; may act as a berm (see berm)

**spray drift**: see off target

**spring**: groundwater flows that become surface water flows upon exiting from the ground (also see watercourse)

**sustainable**: land management practices that provide a flow of goods and services from an ecosystem over long periods of time without degradation of the site or decline in yields

**stewardship**: the conducting, supervising or managing of something, especially the careful and responsible management of something entrusted to one’s care; for example, stewardship of biodiversity on agricultural land

**stewardship crops**: see crops

**stockpiled feed**: forage grown throughout the summer that is saved expressly for grazing during the dormant season (fall, winter, spring)

**stormwater**: the portion of runoff that originates as rainfall precipitation; is one source of runoff (also see runoff)

**detention pond**: a pond constructed to collect peak stormwater flow and then release the water at a reduced rate, no greater than historic flow rates

**peak flow**: when stormwater is flowing at a maximum rate; if the peak flow is increased above historic levels it may cause erosion, habitat loss, etc.

**stormwater management**: ensuring peak flow rates from a farm during storm events are not increased from those prior to a farm development, such as by the use of detention ponds

**stream**: (a) [from the *Forest Practices of BC Code Act*] a watercourse, having an alluvial sediment bed, formed when water flows, on a perennial or intermittent basis, between continuous definable banks; (b) [from the *Water Act*] includes a natural watercourse or source of water supply, whether usually containing water or not, ground water, and a lake, river, creek, spring, ravine, swamp and gulch; (c) any body of running water moving under gravity through a clearly defined natural channel to progressively lower levels (also see watercourse)

**ephemeral stream**: a channel (usually vegetated) where water flows only during and immediately after rainfall or snowmelt, normally for less than 30 consecutive days

**intermittent stream**: a stream (usually unvegetated) with distinct channel development in which water flows during storms or the wet season but dries up during the dry season or drought, usually flows continuously for a month or more; may be either spring-fed or surface fed

**permanent stream**: a well-defined channel where water usually flows all year

“**natural stream**”: see *Agricultural Watercourse Maintenance Guide*

**natural flow**: the flow as it would be if unaltered by upstream diversion, storage, import, export, or change in upstream use caused by development

**stream bed**: [from the *Water Act*] see stream channel

**stream channel**: (a) [from the *Water Act*] the bed of a stream and the banks of a stream, whether above or below the natural boundary and whether usually containing water or not, including all side channels, (b) [from the *Forest Land Reserve Regulation*] the area between the outermost opposing streambanks measured at the point where rooted terrestrial vegetation begins

**stream crossing**: a means, natural or constructed, whereby livestock and/or machinery may cross a watercourse

**in-stream or bed-level**: a crossing constructed at the bottom of a stream with an erosion-resistant surface; water flows over the structure and users must cross through the water

**over-stream or mid-level**: a crossing constructed above the normal water level; water flows under or through the structure and users cross above the water

**stream scour**: see erosion

**strip cropping**: the alternation of crop rows and/or forages across the slope of the land to slow water runoff and reduce erosion

**structurally sound**: see manure storage facility

**subsoilers**: soil-working tool operated below normal tillage depth to break up impervious soil layers and improve root and water penetration

**sufficient capacity**: see manure storage facility
**sulphur oxides (SO₃):** air contaminants resulting from the combustion of fossil fuels or biomass to fuel heating appliances or boilers that contribute to acid rain

**surface water:** water flowing or stored on the earth’s surface (also see groundwater)

**surface water contamination potential:** the potential for contaminants to be transported by water (runoff) into watercourses; influenced by the risk of contaminants to leave storage areas, the distance between contaminants and watercourses, and the pathways from contaminants to watercourses (such as slope of the land, etc.)

**surface water flow:** see runoff

**suspended solids:** solids that are not in true solution and that can be removed by filtration

**swirl chamber:** see windbreak

**target & non-target:** target pest are those which a pesticide is specifically designed to kill; anything else affected by the pesticide is non-target

**off target:** when applying pesticides, indicates unwanted movement of pesticide to environmentally sensitive areas; typically by:

1. **direct transport:** movement of soil, vegetation, and other materials that contain pesticide residue
2. **drift:** movement of spray droplets or vapour in the air
3. **leaching:** movement in the water through soil
4. **runoff:** in water or by pesticide bound to eroding soil

**thalweg:** the deepest part of a stream channel (from Thal = valley, and weg = path)

**tillage:** mechanical soil-stirring action for nurturing crops by providing suitable soil environment for seed germination, root growth, and weed and moisture control

**conservation tillage:** a method which reduces the amount of crop residue incorporated into the soil, but leaves 30% or more of the soil surface covered with crop residue after planting; objectives are soil moisture retention, reduced compaction, and saving of fuel, time, and labour

**minimum tillage:** a system of farming, primarily used in annual crops, that uses the least number of tillage operations to prepare seedbeds, plant crops, control weeds and harvest the crop; can be as few as one tillage pass which involves the application of fertilizer and the planting of the crop; herbicides are often used to suppress weeds; objectives are to save fuel, time, labour, and moisture, and reduce soil compaction

**primary tillage:** first operation in preparing cropland, reaching full depth of intended root zone, unless subsoilers are used (also see plough pan and subsoilers)

**secondary tillage:** follows primary tillage to prepare soil for planting or to control weeds; usually not as deep as primary tillage

**timing window:** indicate when it is appropriate to proceed with the proposed development in water bodies or watercourses. These timing constraints typically coincide with critical periods in the life cycle of fish (reproduction, incubation and nursery activities)

**topography:** description of a landscapes’ features such as hills, valleys, rivers, etc.

**toxin:** a poison produced by a living organism

**transpiration:** the process by which water absorbed by plants, usually through the roots, is evaporated into the atmosphere from the plant surface, principally from the leaves

**treated wood:** wood with chemicals added to slow decay

**water-based preservatives:** preservatives which do not present a significant leaching problem, such as chromated copper arsenic

**oil-based preservatives:** preservatives which leach from wood, such as creosote

**triple rinse:** see rinsing method

**T-sum:** the accumulated mean daily temperatures (in °C) above zero, starting on January 1 (below-zero temperatures are ignored); used as a method to determine when to make the first application of nitrogen fertilizer in the spring; refer to web site [http://www.farmwest.com/climate/tsum/index.cfm](http://www.farmwest.com/climate/tsum/index.cfm)

**ungulate:** a mammal having hooves
**upland**: the area away from the riparian area that shows no effects of the riparian moisture; in dry locations, is easily identified by the brown and yellow vegetation in contrast to the green of the wetter riparian area; farm activities in the upland can impact riparian areas and watercourses

**used oil**: see waste oil

**ventilation**: the movement of air through a farm structure to maintain adequate conditions for livestock or plants; removes moisture, excess heat odours and gases, air-borne dust, and provides fresh air

**natural ventilation**: the use of fixed and adjustable openings in a building, along with natural site and environmental conditions, to achieve air movement

**ventilation index**: see open burning

**volatile organic compounds (VOC)** air contaminants released from manure, some pesticides and petroleum products; contribute to the production of ground level ozone and the formation of fine particulate matter

**volatilize**: the process of chemicals moving from the liquid phase to the gaseous phase

**waste**: [from the *Environmental Management Act*] includes air contaminants, litter, effluent, refuse, biomedical waste, hazardous wastes, and any other substance designated by the Lieutenant Governor in Council

**waste discharge**: the introduction of a waste into the environment

**agricultural exemptions of approvals/permits**: [from the *Agricultural Waste Control Regulation*] a person who carries out an agricultural operation in accordance with the *Code* is, for the purposes of carrying out that agricultural operation, exempt from Section 3 (2) and (3) of the *Environmental Management Act* (the sections prohibiting introducing wastes into the environment except with a waste discharge approval or permit

**waste discharge approval**: [from the *Environmental Management Act*] a director may approve the introduction of waste into the environment for a period of up to 15 months without issuing a permit

**waste discharge permit**: [from the *Environmental Management Act*] a director may issue a permit authorizing the introduction of waste into the environment subject to requirements for the protection of the environment that the manager considers advisable

**waste oil**: [from the *Hazardous Waste Regulation*] automotive lubricating oil, cutting oil, fuel oil, gear oil, hydraulic oil or any other refined petroleum based oil or synthetic oil where the oils are in the waste in a total concentration greater than 3% by weight and the oils through use, storage or handling have become unsuitable for their original purpose due to the presence of impurities or loss of original properties; under the *Hazardous Waste Regulation* cannot be applied to roads for dust suppression

**water**: [from the *Environmental Management Act*] includes groundwater (as defined in the *Water Act*) and ice

**water bar**: an obstruction to divert water from the surface of a road or trail onto an adjacent vegetated area

**water cycle**: see hydrologic cycle

**water intake**: structure for diverting surface water into an open ditch, subsurface drain or pipeline; is sized for the expected flow and is fish-protected as required

**intake maintenance**: work required to ensure the operation of an intake; must be conducted (methods and timing) to minimize impacts to riparian areas and water quality

**water licence**: a legal document issued under the *Water Act* which specifies the terms and conditions under which a right to use (surface) water is granted

**appurtenant**: a water licence belongs, or is appurtenant, to the land of the licensee; on the sale of the land the licence is transferred to the new landowner

**conditional licence**: a licence that authorizes the construction of works or the diversion and use of water before the issue of a final licence; has all the rights of a final licence

**final licence**: a licence that authorizes the diversion and use of water, and does not
authorize the construction of additional works or an extension of the use of water

**priority date**: a seniority system of water rights; usually the licence issuance date; when more than one licence has been issued for a stream, the licence with the earliest priority date has first right to the water

**purpose**: the water use allowed under the licence

**storage**: the conditions of water storage

**unrecorded water**: water the right to the use of which is not held under a licence or under a special or private Act

**water quality**: a term used to describe the chemical, physical, and biological characteristics of water with respect to its suitability for a particular use; for an extensive glossary of water quality terms go to www.env.gov.bc.ca/wat/wq/reference/glossary.html

**clean water**: a relative term from a specific farms point of view; water flowing by or on a farm, regardless of its original water quality, that has not had contamination added by that farms activities; the farm is not responsible for this water quality

**dirty water**: a relative term from a specific farms point of view; water flowing by or on a farm, regardless of its original water quality, that has had contamination added by that farms activities; the farm is responsible for this change in water quality

**drainage water quality**: outlet water quality that does not cause pollution

**irrigation water quality**: water used for irrigation that meets the guidelines given in Table 9.2, page 181, such that soils are protected from salt accumulation and crops are safe to eat

**polluted water**: water containing a natural or man-made impurity

**potable water quality**: [from the Drinking Water Protection Act] water provided by a domestic water system that meets the standards prescribed (in Schedule A of the Regulation) and is safe to drink and fit for domestic purposes without further treatment

**reclaimed water quality**: water that has been treated at a municipal waste treatment facility and is of an acceptable quality to be reused

**water quality guidelines**: specific levels of water quality which, if reached, are expected to render a body of water suitable for a designated purpose

**water quality objective**: a provincial guideline adapted to protect the most sensitive designated water use at a specific location taking local circumstances into account

**water rights**: see water licence

**water supply system**: [from the Drinking Water Protection Act] a domestic water system that serves more than one single-family residence

**water table**: (a) the upper surface of a saturated zone beneath the soil surface (i.e., where all the soil pore spaces are completely filled with water) where the water is at atmospheric pressure; (b) the upper surface of an unconfined aquifer (see aquifer, unconfined; and see soil water); a water table may fluctuate throughout the year

**perched water table**: a water table separated by unsaturated material from an underlying body of groundwater

**watercourse**: [from the Code under the Agricultural Waste Control Regulation] a place that perennially or intermittently contains surface water, including a lake, river, creek, canal, spring, ravine, swamp, salt water marsh or bog, and including a drainage ditch leading into the foregoing (also see stream)

**watercourse access**: a livestock watering method where livestock directly water from a watercourse

**managed access**: the duration, timing, and intensity of livestock access to a watercourse is controlled to minimize impact on water quality and health of the riparian area; access location(s) may be improved with added footing, erosion protection, etc such as gravel, or geotextile and gravel

**unrestricted access**: livestock have full access to a watercourse

**watercourse classification**: see Agricultural Watercourse Maintenance Guide

**watershed**: an area of land that collects and discharges water into a single creek or river through a series of small tributaries

**weed**: unwanted plant; classified on the basis of longevity

**annual weed**: complete their life cycle in less than 12 months, either summer or winter annuals

**aquatic weed**: undesirable plant that grows in water, such as Eurasian Watermilfoil

**biennial weed**: require between 12 and 24 months to complete their life cycle
perennial weed: survive for several years, either creeping or non-creeping types
biological control: weed control of introduced plants by exposing them to their natural enemies
noxious weed: a weed designated and listed by the Weed Control Regulation to be a noxious weed, and includes the seeds of the noxious weed; lists province-wide and regional weeds
weir: (a) a structure across a watercourse to control or divert the flow; (b) a device for measuring the flow of water
well: (a) a pit, hole or shaft sunk into the earth to tap groundwater; (b) [from the Water Act] an artificial opening in the ground made for the purpose (among others) of extracting and using ground water
abandoned well: a well no longer used that has been permanently closed or plugged
artesian well – flowing: [from the Ground Water Protection Regulation] a well in which water (a) naturally rises above the ground surface or the top of any casing, and (b) is observed to flow naturally, either intermittently or continuously (also see aquifer)
artesian well – non-flowing: a well where the water level raises above the water level in the aquifer due to underground hydrostatic pressure (also see aquifer)
drawdown: (a) the lowering of the water surface or water table from the withdrawal of water; (b) the difference between the static water level and the level when pumping at a given discharge
horizontal well: a water source developed by horizontally drilling into a perched water table or underground water source
probable source of contamination: a term used in Public Health Act, Public Health Act Transitional Regulation; (a) [from the Regulations] wells to be separated from probable sources of contamination, such as a privy vault, cesspool, manure heap, stable or pigsty; (b) interpreted in this Reference Guide to include farm sources, such as storages of petroleum, pesticides, compost, woodwaste, etc.
safe well yield: amount of groundwater that can be withdrawn from an aquifer without degrading quality or reducing pumping level (also see recharge)
sand point well: constructed by driving assembled lengths of pipe into the ground composed of loose soils such as sand; usually small diameter (5 cm) and shallow (less than 15 m deep)
well cap: [from the Ground Water Protection Regulation] a secure, vermin-proof cover, lid or structure that prevents direct and unintended or unauthorized access to the interior of the production casing, and includes a sanitary well seal
well test: determination of the well yield versus drawdown relationship with time
well casing: [from the Ground Water Protection Regulation] pipe, tubing or other material installed in a well to support its sides
casing above ground: the extension of a well casing above the ground level (0.3 m suggested) to prevent the entrance of surface water into the inside of the casing and contaminating groundwater
sealant: [from the Ground Water Protection Regulation] (a) a non-toxic, commercially available material or mixture of materials, including (i) bentonite clay, (ii) bentonite clay and water mixture, (iii) bentonite clay and sand and water mixture, (iv) neat cement grout, (v) sand cement grout, and (vi) concrete grout, or (b) a non-toxic material or mixture of materials that has a lower permeability than the surrounding geologic formation to be sealed
surface seal: [from the Ground Water Protection Regulation] a sealant placed in the annular space around the outside of the outermost well casing and between multiple well casings and extending to or just below the ground surface (see sealant, above)
pitless adaptor: [from the Ground Water Protection Regulation] a mechanical device attached to a well casing, usually below the frost-level, for underground conveyance of water to or from the well (note – used to eliminate the water quality concerns of a dug pit around a below-ground surface well casing)
wetland: (a) area of wet soil that is inundated or saturated long enough to promote wetland or aquatic processes as indicated by the presence of poorly drained soils, hydrophytic (water loving) plants, and various kinds of biological activity adapted to a wet environment; (b) [from Forest Practices Code of BC Act] swamp, marsh, bog or other similar area that supports natural vegetation that is distinct from adjacent upland areas
wet meadow: a meadow where the surface remains wet or moist throughout the growing season, usually characterized by plants such as water-tolerant grasses, sedges and rushes
wildlife: [from the Wildlife Act] raptors, threatened species, endangered species, game or other species
of vertebrates prescribed as wildlife and includes fish, but does not include species at risk

**amphibian**: [from the *Wildlife Act*] a vertebrate of the class Amphibia and includes the eggs and other developmental life stages

**big game**: [from the *Wildlife Act*] (a) any member of the family Cervidae, (b) mountain sheep, mountain goat, bison or pronghorn antelope, (c) bear, cougar or wolf, or (d) a mammal prescribed as big game

**bird**: [from the *Wildlife Act*] an animal of the class Aves, and its eggs

**dangerous wildlife**: [from the *Wildlife Act*] bear, cougar, coyote or wolf, or a species of wildlife that is prescribed as dangerous wildlife; it is unlawful to feed dangerous wildlife

**fish**: [from the *Wildlife Act*] any (a) vertebrate of the order Petromyzontiformes (lampreys) or class Osteichthyes (bony fishes), or (b) invertebrate of the class Crustacea (crustaceans) or class phylum Mollusca (mollusks) from or in non-tidal waters of British Columbia, and includes their eggs and juvenile stages

**game**: [from the *Wildlife Act*] big game, small game, game birds and fur bearing animals, and other species prescribed as game

**problem wildlife**: wildlife that conflict with agricultural production, such as grazing farms, pastures, or damaging fruit or vegetable crops

**raptor**: [from the *Wildlife Act*] a bird of the order Falconiformes known as vultures, eagles, falcons and hawks or the order Strigiformes known as owls, and includes its eggs

**winter precipitation**: total precipitation during the period of October 1st to April 30th inclusive

**wood-fired boiler**: see boiler

**woodlands**: farm woodlots that may be operated on privately owned or Crown land

**woodwaste**: [from the *Code under the Agricultural Waste Control Regulation*] includes hog fuel, mill ends, wood chips, bark and sawdust, but does not include demolition waste, construction waste, tree stumps, branches, logs or log ends

**woodwaste leachate**: the liquid generated from water moving through woodwaste; characterized by a dark colour, “oily” sheen and a foul odour

**woody debris**: wood from trees and shrubs that is scattered on the ground or in the water; returns essential nutrients into the soil or water as it decays; may provide critical habitat for fish and wildlife

**works**: (1) [from the *Water Act*] (a) anything capable of or used for (i) diverting, storing, measuring, conserving, conveying, retarding, confining or using water, (ii) producing, measuring, transmitting or using electricity, or (iii) collecting, conveying or disposing of sewage or garbage or preventing or extinguishing fires; (b) booms and piles placed in a stream; (c) obstructions placed in or removed from streams or the banks or beds of streams; and (d) changes in and about a stream, and includes access roads to any of them

(2) [from the *Environmental Management Act*] (a) a drain, ditch, sewer, (b) a waste disposal system including a sewage treatment plant, pumping station and outfall, (c) a device, equipment, land and a structure that (i) measures, handles, transports, stores, treats or destroys waste or a substance that is capable of causing pollution, or (ii) introduces into the environment waste or a substance that is capable of causing pollution, or (d) an installation, plant, machinery, equipment, land or a process that causes or may cause pollution or is designed or used to measure or control the introduction of waste into the environment or to measure or control a substance that is capable of causing pollution, or (e) an installation, plant, machinery, equipment, land or a process that monitors or cleans up pollution or waste
## Table E.1 Metric to Imperial Conversions

<table>
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<th>Metric Unit</th>
<th>Conversion Factor</th>
<th>Imperial or US Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area</strong></td>
<td>square metres (m²)</td>
<td>10.76</td>
<td>square feet (ft²)</td>
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<td></td>
<td>hectares (ha)</td>
<td>2.47</td>
<td>acres (ac)</td>
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<td><strong>Concentration</strong></td>
<td>microgram/gram (µg/g)</td>
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<td>parts/million (ppm)</td>
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<tr>
<td><strong>Flow</strong></td>
<td>metres/second (m/sec)</td>
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<td>feet/second (ft/sec)</td>
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<td></td>
<td>litres/minute (L/min)</td>
<td>0.26</td>
<td>Liquid gallons/minute (g/m)</td>
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<tr>
<td><strong>Length</strong></td>
<td>millimetres (mm)</td>
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<td>inches (in)</td>
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<td></td>
<td>centimetres (cm)</td>
<td>0.39</td>
<td>inches (in)</td>
</tr>
<tr>
<td></td>
<td>metres (m)</td>
<td>3.28</td>
<td>feet (ft)</td>
</tr>
<tr>
<td></td>
<td>kilometres (km)</td>
<td>0.62</td>
<td>miles (mi)</td>
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<tr>
<td><strong>Pressure</strong></td>
<td>megapascals (MPa)</td>
<td>145</td>
<td>pounds/square in (psi)</td>
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<tr>
<td><strong>Temperature</strong></td>
<td>degrees Celsius (°C)</td>
<td>1.8, then add 32</td>
<td>degrees Fahrenheit (°F)</td>
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<tr>
<td><strong>Volume</strong></td>
<td>litres (L)</td>
<td>0.26</td>
<td>Liquid gallons (gal)</td>
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<td></td>
<td>litres (L)</td>
<td>0.035</td>
<td>cubic feet (ft³)</td>
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<td></td>
<td>cubic metres (m³)</td>
<td>1.31</td>
<td>cubic yards (yd³)</td>
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<tr>
<td><strong>Volume/Area</strong></td>
<td>cubic metres/hectare (m³/ha)</td>
<td>14.29</td>
<td>cubic feet/acre (ft³/ac)</td>
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<td><strong>Weight</strong></td>
<td>kilograms (kg)</td>
<td>2.2</td>
<td>pounds (lb)</td>
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<td></td>
<td>metric tonnes (t)</td>
<td>1.1</td>
<td>tons (t)</td>
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<tr>
<td><strong>Weight/Area</strong></td>
<td>kilograms/hectare (kg/ha)</td>
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<td>pounds/acre (lb/ac)</td>
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<td>tonnes/hectare (t/ha)</td>
<td>0.45</td>
<td>ton/acre (t/ac)</td>
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<td><strong>Weight/Volume</strong></td>
<td>milligram/litre (mg/L)</td>
<td>1</td>
<td>parts/million (ppm)</td>
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