



Photo: Jeannette Greaves

# Wintering Site

## Assessment and Design Tool

A Guide to Selecting and Managing a  
Wintering Site in Western Canada

*Managing for Good Environmental Stewardship*

**Agdex #420/580-3**



Agriculture and  
Agri-Food Canada

Agriculture et  
Agroalimentaire Canada





## A Guide to Selecting and Managing a Wintering Site in Western Canada

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# Introduction

The practice of feeding cattle in a field setting during the winter, called extensive winter feeding, is increasing across the Prairies. The main driver behind this increase is reduced yardage, feeding, and manure hauling costs. Extensive winter feeding also converts nutrients in the feed into “natural” fertilizer placed on the field, increasing soil fertility and enhancing yields on the site.

Careful site selection and good site management practices are both essential to ensure that producers receive the benefits of winter feeding while addressing the potential environmental concerns. However, winter feeding also comes with some environmental risks. In particular, there is a risk of excessive nutrient accumulation at the site and an increased potential for these nutrients to be transported into surface or groundwater sources in the surrounding watershed.

The Wintering Site Assessment and Design Tool (WSADT) is designed to assist producers in identifying the environmental risks associated with extensive wintering sites, weighing the risks of one situation against another, and considering the adoption of beneficial management practices (BMPs) to address the risks.



Photo: Jeannette Greaves

Extensive winter feeding: livestock fed in a field setting.

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**An objective of a winter feeding system is to meet the animal's needs while minimizing the risk to the environment.**

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Photo: Dale Timmerman - AAFC

Post winter feeding site management

The choice of which particular BMP to use will depend on the wintering site's characteristics, the local climate, feeding strategies, costs, and other factors.

**WSADT Covers Five Main Considerations For Wintering Site Selection And Management:**

1. Site characteristics
2. Feeding strategies
3. Bedding and shelter management
4. Water source management
5. Post-wintering site management

Whatever choices producers make regarding site selection and management practices, their wintering system must meet their herd's daily nutrient requirements and must provide sufficient water, bedding, and shelter to meet the animals' health and welfare needs at all times.

The development of this publication is an update on the science and research from the previous publication “Cattle Wintering Sites” produced by Alberta Beef Producers, Prairie Farm Rehabilitation Administration, and Alberta Agriculture Food and Rural Development in 2001. Ongoing and completed research from the time of release of Cattle Wintering Sites; included Agriculture and Agri-Food Canada, Alberta Agriculture and Rural Development, Manitoba Agriculture Food and Rural Initiatives, Western Beef Development Centre, University of Alberta, University of Saskatchewan, and University of Manitoba; has been incorporated into the information provided in this publication. Please refer to the Resources on Pg. 49.

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**Consumers are becoming more aware about how their beef is raised from both animal welfare and environmental perspectives.**


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## Tool Concept

The Wintering Site Assessment and Design Tool (WSADT) covers a range of site characteristics, feeding strategies and design, and other considerations related to extensive cattle wintering sites on the Canadian Prairies. For each factor, WSADT identifies the level of environmental risk, outlines potential causes for concern, and provides recommendations on beneficial management practices (BMPs) to help manage the risk and protect the environment when selecting and managing the site.

### Risk Level

 WSADT uses a traffic light format (green, yellow, red) to indicate the level of environmental risk without taking any additional mitigation practices into account.



#### Red – High Risk

These site conditions and/or practices pose the greatest potential risk to the environment if the site is used for wintering cattle. Some factors, including slope, soil type, and flood hazard, cannot be controlled, so it may be necessary to consider relocating the wintering site to a lower risk area and/or making significant management changes to reduce or eliminate the risk.



#### Yellow – Medium Risk (Proceed With Caution)

Some alteration of the site or change of management practice may be necessary to reduce or eliminate environmental risks.



#### Green – Low Risk

With continued good management, the wintering site will generally not require any alteration of the site or change of practice to protect the environment.

## Steps for Using WSADT Charts

**1.** In each WSADT chart, identify your current situation in the left-hand portion of the chart.













**2.** Consider the level of environmental risk associated with your current situation.

**3.** Consider the potential concerns.

**4.** Consider the options for BMPs to address the concerns.

**5.** Go to the Resources section of this publication to find detailed information to help you decide which particular BMPs would best meet the needs of your own operation.

### Example:

Site Characteristic	Environmental Risk Factor and Risk Level			Potential Concerns	Beneficial Management Practices
Slope length of wintering site	Less than 300 ft	300 ft to 1300 ft (1/4 mile)	Greater than 1300 ft	With longer slopes, the potential for increased water flow/velocity and associated erosion and/or nutrient transport increases.	<ul style="list-style-type: none"> <li> If possible, place feeding areas on slopes less than 300 ft in length. For longer slopes, add berms or other barriers to slow runoff.</li> <li></li> <li></li> </ul>
Depth to groundwater	Greater than 100 ft	25 ft to 100 ft	Less than 26 ft	The risk of nutrients contaminating groundwater increases on sites with shallow, permanent water tables.	<ul style="list-style-type: none"> <li> Move site to high ground or a location that is at least 25 ft above the water table.</li> <li></li> <li></li> </ul>
Amount of bare ground on Perennial forage or annual cropland	Perennial pasture with <25% bare ground	Annual cropland with stubble and aftermath with 25 to 50% bare ground or perennial pasture with >25% bare ground	Annual cropland with >75% bare ground	There is a greater risk of nutrient, pathogen, and sediment movement into water sources if the site has little groundcover or crop residue.	<ul style="list-style-type: none"> <li> Select a site with good groundcover or establish groundcover so that at least 75% of the surface is covered with plant material prior to winter feeding.</li> <li></li> <li></li> <li> For annual cropland, do not use fall tillage prior to winter feeding.</li> <li></li> <li></li> </ul>

## Environmental Risks

A wintering site includes feeding, bedding, and watering areas plus any other areas the cattle have access to. The site's environmental risks are mostly related to the movement of nutrients, pathogens (disease-causing organisms), and sediments from the site into surface or groundwater sources, but there can be other environmental risks too.

Not only are environmental impacts a growing public concern, but nutrient loss from a wintering site is an economic loss for the producer because of the lost opportunity to use those nutrients to improve crop yields and decrease fertilizer requirements.

## Water

The main water-related environmental risks of wintering sites are risks to water quality. Without proper site selection and management, extensive feeding systems could contribute to the contamination of water sources with manure nutrients, pathogens, and sediment.

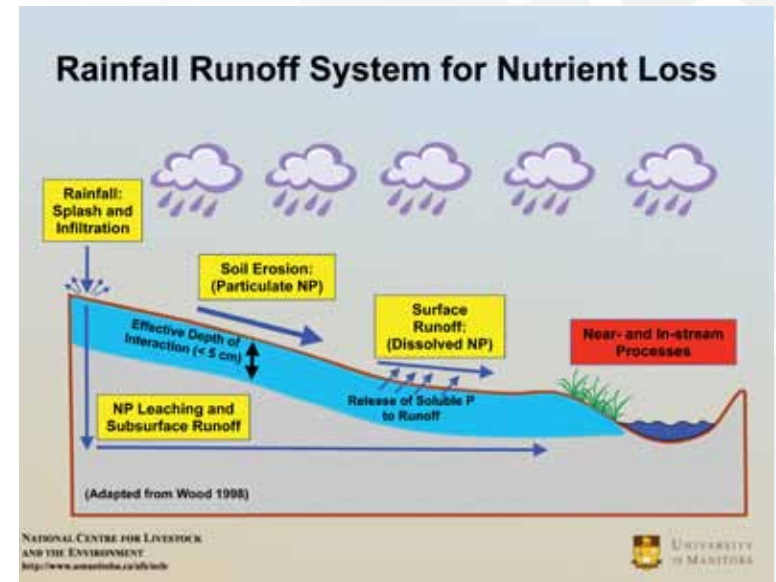
Water quality degradation could potentially create health concerns, increase water treatment costs, and degrade habitat quality. For example, excessive nutrients, especially phosphorus, promote the growth of plants and algae in water. Enhanced growth of aquatic vegetation disrupts normal functioning of the ecosystem, causing a variety of problems including lower oxygen levels in the water, which can lead to the death of fish and other aquatic organisms. Enhanced growth of blue-green algae can also lead to the release of toxins into the water when the algae bloom dies. Manure pathogens, such as certain strains of the bacterium *Escherichia coli* (*E. coli*), can cause illness in humans. Sediments impair water

treatment processes, and sediment deposition can reduce storage capacity in waterbodies and harm aquatic habitat.

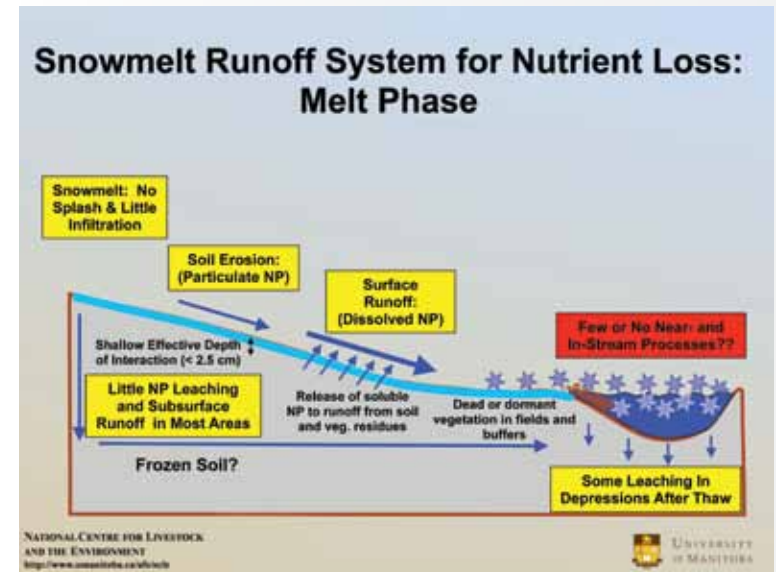
Nutrients, sediments, and pathogens can potentially be transported by surface runoff into local surface waterbodies (creeks, streams, rivers, dugouts, wetlands, ponds, and lakes). In runoff, nutrients may be dissolved in the water or attached to sediments.

Nutrients can also potentially be leached, dissolved in water and carried downward, through the root zone and into groundwater aquifers.

Most runoff (approximately 80%, University of Manitoba) from a wintering site usually occurs as a result of snowmelt when the ground is frozen. Under these conditions, the depth of interaction between the soil and runoff is minimal, so there is little water infiltration and little risk of leaching, as well as no opportunity for nutrients to be absorbed by the soil. Also, dead or dormant vegetated buffers tend to be less effective at slowing down water flow, so they trap less sediment and nutrients than growing plants. As well, dead or dormant plants provide minimal biological uptake of nutrients in the runoff. Therefore, in comparison to summer conditions, snowmelt runoff results in less nutrient leaching but more nutrient transport by surface runoff (see illustrations to the right).



Typical summer runoff



Typical winter runoff

Water quality can also be impacted if cattle are allowed direct access to a waterbody, i.e. allowed to directly enter the water source. They can contaminate the water with manure containing nutrients and pathogens. In addition, they may physically disturb the banks of waterways and waterbodies, resulting in bank erosion and increased sedimentation in the water.

## Soil

Extensive winter feeding can affect soil quality if not managed at the site. Nutrient and salt levels may build up in the soil especially around watering, feeding, and bedding areas where cattle tend to linger (loaf). Excessive soil nutrient levels could result in problems for subsequent crops, like elevated nitrate levels or increased cereal crop lodging. Accumulation of salt in the soil could reduce crop productivity or limit crop selection to salt-tolerant types.

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Along with causing environmental problems, allowing cattle direct access to a waterbody may have negative impacts on cattle. For instance, direct access may increase total dissolved solid levels in the water, which results in a reduction in animal performance, including reduced weight gain. Direct access may also cause an increased incidence of foot rot and sometimes puts cattle at risk of drowning by breaking through the ice.

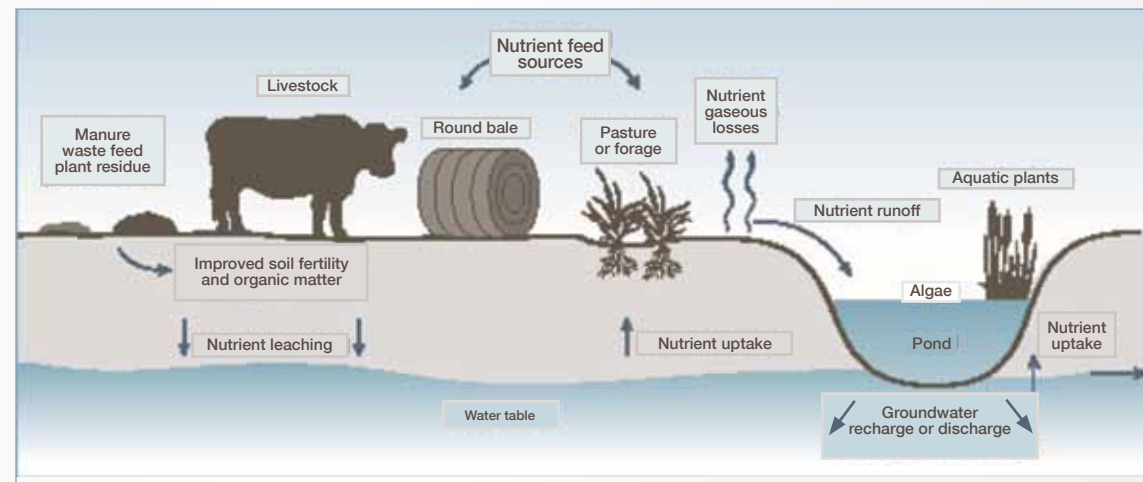
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In addition, concentrated physical impact of livestock can be damaging to soil structure and health if not managed. When soils are wet, livestock movement can result in soil compaction, which can have a huge impact on the growth and productivity of subsequent perennial or annual crops. Wet, compacted soil reduces water infiltration thus increasing the potential for nutrient rich runoff and erosion when compared to dry, non-compacted soils. This increases the risk of nutrients and water leaving a site and in some cases results in water pooling on the soil surface, especially in depressions and wheel tracks. In addition to the surface loss of nutrients and water from a site, compacted soils can lower yields of both annual and perennial crops by restricting root growth thus further limiting nutrient and moisture uptake.

A properly managed extensive feeding system can have a beneficial impact on poor soils, because nutrient and organic matter contributions from the system can improve soil structure and health.

## Air

All livestock production systems release nutrients into the air, regardless of the site, season or system in which the animals produced. The loss of nutrient to the air can impact air quality and create odours. Nitrogen and carbon can be released to the air in the form of carbon dioxide, methane and nitrous oxide, common greenhouse gases. Nitrogen can also be lost from manure as ammonia gas, which is commonly associated with odour but can also contribute to air born particulate matter; reducing air quality.



Wintering site nutrient flows





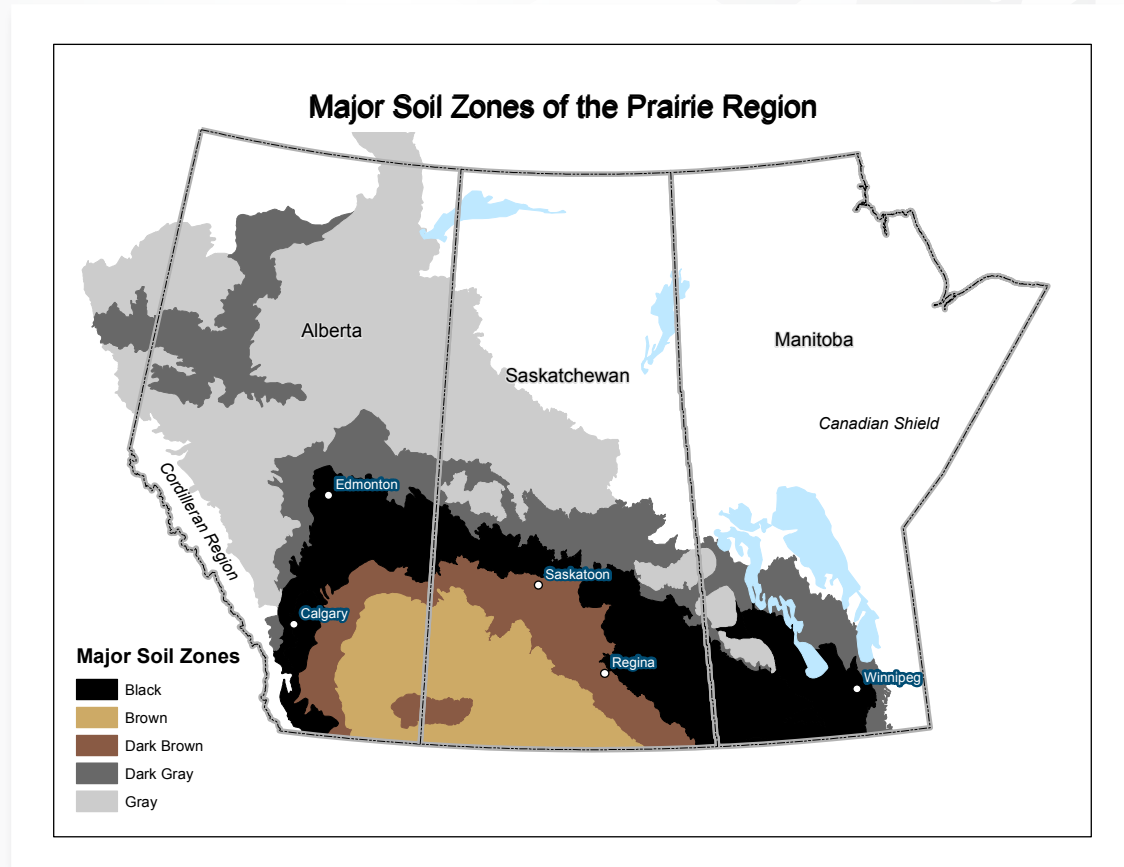
## Site Characteristics

The natural characteristics of a site determine its suitability as an extensive winter feeding location and influence which management practices are appropriate for the site. While producers are unable to control all site characteristics, they may be able to reduce the environmental risks associated with wintering sites by adopting one or more of the BMPs identified in this publication.

Precipitation and runoff typically increases from the Brown to Black to Dark Gray Soil Zones. The higher the runoff, the greater risk of nutrient, pathogen and sediment transport.

For example, if a wintering site is located in an area that typically receives a large amount of snowfall, surface runoff losses of nutrients are an issue.

A producer may decide to feed and water the animals in parts of the field farthest away from surface water sources. Alternatively, if the site has patches of gravelly soils where nutrient leaching into the groundwater is a concern, the producer could feed the cattle away from the gravelly patches to lessen the risk of groundwater contamination.









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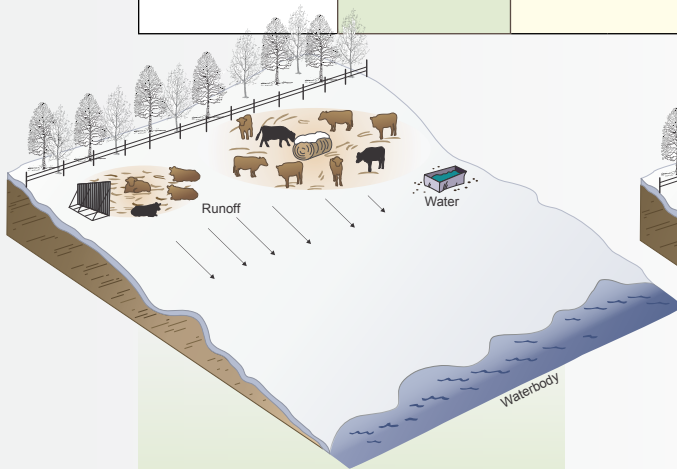
## Soil, Slope, and Water Flow Characteristics

Table 1 lists important site characteristics and their level of environmental risk, and identifies BMPs that could be adopted to reduce these risks.

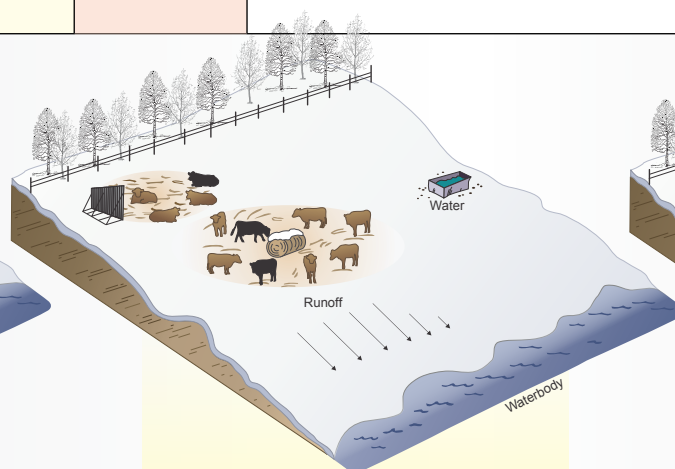
*Table 1. Environmental Risks and BMPs Related to Various Site Characteristics*

Site Characteristics	Environmental Risk Factor and Risk Level			Potential Concerns	Beneficial Management Practices
Soil zone	Brown Dark Brown	Black or Irrigated land	Dark Gray	<p>Precipitation and runoff typically increase from the Brown to Black to Dark Gray Soil Zones. The higher the runoff, the greater the risk of nutrient, pathogen and sediment transport.</p> <p>Excessive irrigation can increase runoff potential and associated nutrient and sediment transport.</p>	<p> Construct diversions or catch basins to manage or reduce run-on and runoff from the site.</p> <p> Manage irrigation systems (e.g. maintain field capacity matched to crop uptake) to reduce the opportunity for runoff.</p>
Soil type	Clay	Silty/loam	Sandy, gravelly and/or bedrock exposure Peaty/mucky soils Solonetzic soils or saline soils	<p>Clay soils have the lowest leaching potential due to their high water-holding capacity. Sandy and gravelly soils and shale or sandstone outcrops are prone to leaching and provide a direct conduit into local groundwater. The higher the leaching potential, the greater the risk for nutrients to move into the groundwater.</p> <p>Peaty soils indicate a high water table, which increases the risk of groundwater contamination.</p> <p>Solonetzic and saline soils have a reduced ability to utilize nutrient build-up associated with winter feeding.</p>	<p> Avoid if possible sites with sandy/gravelly soils and bedrock outcroppings.</p> <p> Move feeding, bedding and watering areas to better soil types within the wintering site.</p>
Snowmelt conditions	Ground not frozen and/or slow to medium rate of snowmelt with most water being absorbed and very little runoff	Ground partially frozen with medium to fast melt causing some runoff or Unfrozen ground with fast melt causing some runoff	Frozen ground with most water running offsite	The risk of nutrients contaminating surface water increases on sites that typically have snowmelt occurring when the ground is frozen and/or have fast snowmelts. In these situations, less water is absorbed into the soil and more water runs off.	<p> Select sites that minimize the potential amount of run-on onto the site and runoff from the site.</p> <p> Construct diversions or catch basins to manage or reduce run-on and runoff from the site..</p> <p>**See Flooding pg 30 and Runoff pg 32 for additional BMPs.</p>
Flooding	0 to 25% of the wintering site is flooded	25 to 50% of wintering site is flooded	50% or more of the wintering site is flooded	Flooding results in the direct transfer of nutrients and sediment into surface waterbodies.	Risks due to flooding are dependent on the feeding system and the frequency of flooding. See Flooding pg.30.

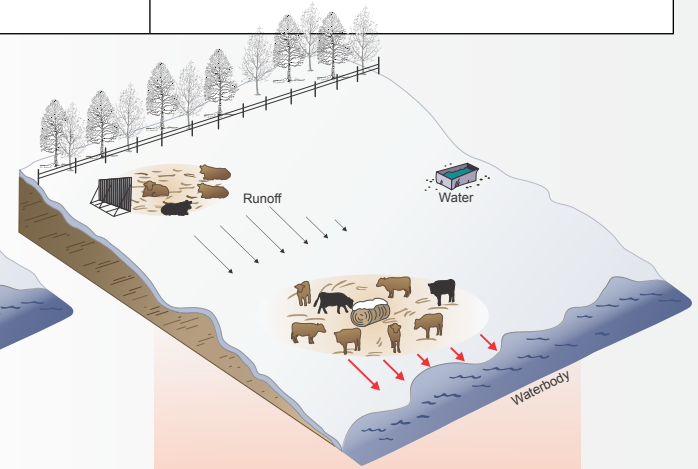
Site Characteristics	Environmental Risk Factor and Risk Level			Potential Concerns	Beneficial Management Practices
Water running <b>onto</b> wintering site	No run-on to wintering site or run-on diverted by installed works	Run-on enters wintering site		The risk of nutrients contaminating surface water increases when runoff from adjacent fields flows through a wintering site.	<ul style="list-style-type: none"> <li>● Control or divert run-on if necessary depending on site conditions and feeding strategy. Select sites from which the runoff is captured or does not enter surface water sources.</li> <li>● Locate wintering sites on high points in the landscape to minimize run-on water.</li> </ul>
Water runoff <b>from</b> wintering site	No runoff leaves wintering site or runoff managed by installed works	Runoff leaves wintering site		Runoff from a wintering site has the potential to contaminate surface water and groundwater with nutrients and pathogens.	See Runoff pg 32.
Slope position of wintering site	Upper slope	Mid slope	Lower slope or floodplain	Sites located in lower slope positions or adjacent to riparian areas may be subjected to flooding, leaching or already have high soil fertility levels.	<ul style="list-style-type: none"> <li>● If needed, construct diversions or catch basins to prevent runoff into surface waterbodies.</li> <li>● Place feeding, bedding, and watering areas on upper slope positions rather than lower slope positions.</li> </ul>



● Feeding Location Up-Slope



● Feeding Location Mid-Slope



● Feeding Location Down-Slope









Site Characteristics	Environmental Risk Factor and Risk Level			Potential Concerns	Beneficial Management Practices
Slope steepness of wintering site	Less than 2% (slight)	2% to 10% (moderate)	Greater than 10% (steep)	The steeper the slope, the greater the risk of nutrient and sediment transport by runoff.	<ul style="list-style-type: none"> <li> For slopes greater than 10%, move the site or install stability, diversion and/or catchment infrastructure.</li> <li> If a sloped area is the only option, locate bedding, watering, and feeding areas as far as possible from any waterways and water runs, and in a spot where runoff is least likely to flow in the direction of the waterway.</li> </ul>
Slope length of wintering site	Less than 300 ft	300 ft to 1300 ft (1/4 mile)	Greater than 1300 ft	With longer slopes, the potential for increased water flow/velocity and associated erosion and/or nutrient transport increases.	<ul style="list-style-type: none"> <li> If possible, place feeding areas on slopes less than 300 ft in length. For longer slopes, add berms or other barriers to slow runoff.</li> </ul>
Depth to groundwater	Greater than 100 ft	25 ft to 100 ft	Less than 25 ft	The risk of nutrients contaminating groundwater increases on sites with shallow, permanent water tables.	<ul style="list-style-type: none"> <li> Move site to high ground or a location that is at least 25 ft above the water table.</li> </ul>
Amount of bare ground	Perennial pasture with <25% bare ground	Annual cropland with stubble and aftermath with 25 to 50% bare ground <i>or</i> Perennial pasture with >25% bare ground	Annual cropland with >75% bare ground	There is a greater risk of nutrient, pathogen, and sediment movement into water sources if the site has little groundcover or crop residue.  When NOT frozen, groundcover or crop residue helps slow runoff and trap nutrients, pathogens, and sediment.	<ul style="list-style-type: none"> <li> For annual cropland, do not use fall tillage prior to winter feeding.</li> <li> Select a site with good groundcover or establish groundcover so that at least 75% of the surface is covered with plant material prior to winter feeding.</li> </ul>
Site history	Stockpiled forage grazing  Swath grazing  Grazing annual crop residues	Corn grazing  Forage baled and fed on the same site	Imported feed  Previously confined feeding site	See Frequency of Feeding on a Wintering Site section.	**See Frequency of Feeding on a Wintering Site pg 27 and Post Wintering Site Management pg 44.



Photo: Jeannette Greaves

## Feeding Strategies

Nutrient accumulation at a wintering site depends on the feeding strategy, which includes the feeding system, feeding intensity, amount of feed used, nutrient levels in the feed, and the frequency of site use for wintering. A significant amount of nutrients can be deposited at the wintering site in the manure and feed waste. As nutrient accumulations increase, the risk of nutrients moving from the site into water sources by runoff or leaching also increases.

# Feeding Systems

Winter feeding strategies can be grouped into two main types: non-imported feeds, which are grown and consumed on the same site; and imported feeds, which are feeds grown at a different location and hauled to the site.

Imported feeding systems have greater potential environmental concerns because they tend to add more nutrients to the feeding area and they have a greater potential for localized nutrient concentrations, or nutrient hot spots. However, nutrient hot spots can occur in any feeding system if cattle are allowed to continually linger in fixed locations for feed, shelter, bedding, and/or water.



## Non-imported Feeds

Non-imported feeding systems can be categorized into lower-input or higher-input systems. Lower-input systems have relatively lower environmental risks.

All of these systems extend the grazing season and help reduce feed, labour, and manure handling costs for the livestock operation. Because the animals are grazing across the entire field, manure and feed wastes are distributed across the field, and nutrient hot spots are much less likely.

### *Lower-input feeding systems*

Lower-input systems include: grazing of stockpiled forages, swath grazing, grazing of annual forages, and grazing of annual crop residues.

The impact of these systems on nutrient loading is minimal because nutrient inputs are relatively low before, during and after winter feeding. Fertilizer inputs for the preceding crop should not exceed its nutrient needs. During the wintering season, manure and feed wastes are distributed across the field. And after, the nutrient uptake of the subsequent crop usually exceeds nutrient inputs from manure and feed wastes, reducing the accumulation of nutrients.





### ***Grazing Stockpiled Forage:***

This practice delays the grazing of native or tame perennial pasture or hay fields to the fall and winter, after forage growth has stopped (i.e. plants are dormant). Stockpiled forage can be used through the winter or in early spring before new pasture growth is available.

- Grazing these pastures early in the growing season is recommended to minimize heading and maintain forage quality for late-season grazing.

### ***Grazing Annual Forages:***

This practice is similar to stockpiled forage grazing. It involves the use of spring- or fall-seeded cereals, winter annuals, annual legumes or combinations thereof, which are left standing for cattle to graze during the winter.

- Winter cereals may be seeded in the early fall and lightly grazed later in the fall, or overwintered and grazed in the spring.
- When planning to overwinter a cereal crop, winter hardiness becomes important. Fall rye is by far the most winter hardy, followed by winter triticale and then winter wheat. Winter cereals can also be seeded in the spring and grazed in the year of seeding. If kept into the next year, spring-seeded winter cereals have significantly lower hardiness than when seeded in the fall.
- Using annual crops, rather than perennial pastures, for winter grazing can minimize grazing impacts on perennial forage regrowth.

### ***Swath Grazing:***

In swath grazing, cereal crops are grown and then cut at the early to mid dough stage and before killing frosts, and left in swaths for livestock to access during the winter. Animals are allowed to forage for feed and their manure is deposited across the site.

- For swath grazing to be successful, good management is needed to keep cattle healthy and in good condition. Feed, fencing, water, and shelter need to be carefully planned.





### ***Annual Crop Residues:***

Annual crop residues can include standing stubble, chaff piles, straw in swaths or other crop residues remaining from the growing season. Cattle can be allowed to feed or graze on this residue.

- Chaff and chaff/straw type roughages are more suitable for mature animals in good body condition. Supplementation may be required to meet the nutritional needs of younger animals and cows in later stages of gestation. Feed analysis and monitoring of cow condition are recommended.
- Chaff piles left in the field may be grazed or moved to a central feed pile and fed. Field feeding of chaff is inexpensive, efficient, and effective.
- Chaff may be collected in a chaff box, whole bunches, or chaff wagon behind a combine harvesting an annual crop to provide the chaff piles.
- The potential for nutrient accumulation is especially low in this system because most of the higher quality portion of the crop (i.e. the grain) is removed; the remaining residues have much lower nutrient levels.
- If the chaff is moved to a central feeding pile, the risk of nutrient concentration will increase somewhat, but nutrient accumulations will still likely be fairly low.



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**To reduce feed wastage, limit cattle access to a small portion of the field at a time. This can be achieved by using a moveable electric fence. The producer regularly monitors the feeding area and changes the fence location as soon as cattle need access to the next portion of the field.**

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Photo: Jeannette Greaves

### ***Higher-Input Feeding Systems***

Corn grazing is the most common higher-input system, although irrigated crops may also have high inputs. As with the lower-input non-imported systems, the forage is spread across the field, so the manure and feed wastes are distributed across the field. However, the higher inputs increase the risk of nutrient accumulation on the site.

#### ***Corn Grazing:***

In this feeding system, corn is planted and then left standing for grazing in the fall or winter.

- Corn requires higher fertilizer application rates to optimize yield compared to annual cereal or forage crops, so the risk of nutrient accumulation is greater.
- Corn has high dry matter yields so corn grazing usually requires a higher feeding intensity (cow days per acre) than other types of non-imported feeding systems. As a result, more manure and feed wastes accumulate on corn grazing sites.
- If a high-input crop is grown on the site after winter feeding, then that crop's nutrient requirements usually exceed the nutrient input from winter feeding, helping to address the risk of nutrient accumulation.



Photo: Jeannette Creaves.



Photo: Dennis Lasuka

## Imported Feeds

Imported feeding systems include bale grazing, unrolling or processing hay, and feeding silage. Although these systems have a higher potential environmental risk than non-imported feeds, they also offer an opportunity to add nutrients on nutrient-deficient areas such as eroded hill tops or overgrazed pastures.

Cattle tend to linger around feeding areas, causing nutrient hot spots. So imported feeding systems need to be managed to encourage the cattle to move around the site.

Another risk from imported feed is the potential to introduce new weeds to the site, which can negatively impact productivity and health of the following crops.

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**For imported feeds, manage the placement of and access to bales, or move portable feeders or bunks frequently, to distribute nutrients more evenly.**

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Photo: Gary Makoweck | AAFC

### ***Bale Grazing***

Bale grazing is a relatively new concept that is catching on in western Canada. It involves allowing livestock to graze bales extensively on pastures, hayland or cropland rather than in confined areas. Round bales are distributed across the feeding area, after either being produced within the same field or moved in from other locations.

- Bale grazing offers the potential to reduce labour and machinery costs for imported feed systems.
- The spacing of bales affects the concentration and the distribution of nutrients deposited across the field. The closer the spacing, the higher the potential for nutrient hot spots. Bale spacing recommendations are provided in Tables A2 and A3 on pages 52 and 53.
- Using a portable electric fence to restrict cattle access to a few bales at a time is recommended to reduce feed wastes. Research has shown that approximately 15 to 20% waste occurs with bale grazing when an electric fence restricts feeding. With unrestricted access, waste is considerably higher.
- If the bales are imported, the potential for nutrient accumulation is high because each bale can contain significant nutrient amounts.
- The nutrients deposited at the site may exceed the nutrient requirements of the subsequent crop, which increases the accumulation of nutrients.

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#### **Example of calculations for nutrient deposition based on bale spacing:**

**If average quality 1300-lb mixed alfalfa grass hay bales are placed in a grid on 25-ft centres, then 371 lb of nitrogen per acre becomes available from the manure and wasted hay for crops grown on the site over the next three to four years.**

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**The use of a portable bale or bunk feeder is recommended to reduce feed wastes. Frequent moving of the bunks reduces the accumulation of nutrients around the bunks.**

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### *Unrolling or Processing Hay*

In this feeding system, bales of forage (hay, greenfeed or straw) are unrolled or processed/chopped (with a bale processor) and placed onto the snow. Bale processing can offer an opportunity for the use of poorer quality feed by chopping and placing it on top of better quality forage.

- Research from Alberta has found that using unrolled hay to feed cattle results in 13% waste, while using hay processed by a bale processor results in 19% waste. (See Table 2; Pg 22)
- The use of portable bunk feeders is recommended to reduce feed wastes. Moving these portable feeders on a regular basis is recommended to distribute the nutrients around the winter feeding area.
- The potential for nutrient accumulation is moderate to high because this practice imports significant nutrients onto the site with each bale. It is recommended that the forage be spread over as large an area as possible over the course of the feeding period to spread the manure and feed wastes over large area.
- Depending on how the site and feed are managed, the nutrients deposited at the site may exceed the nutrient requirements of the subsequent crop, increasing accumulation of nutrients.

### *Other Types of Round Bale Feeding Systems:*

Round bales of hay can be fed in different types of ring feeders, cone feeders, and multi-bale feeders. Some of these feeders can also be used for big square hay bales. Most of these types of feeders are also portable and can be used to feed in different locations.

- The potential for nutrient accumulation is moderate to high because this practice imports significant nutrients onto the site with each bale, and it tends to concentrate feed wastes and manure around the feeders. The longer the feeders remain at the same spot, the higher the potential for nutrients to accumulate.
- If nutrient hot spots occur, they will exceed the nutrient requirements of the subsequent crop, increasing the risk of nutrient movement into water sources.

### Feed Wastage For Imported Feeds:

Table 2 summarizes the amount of feed wastes generated from the different imported feed options.

**Table 2. Feed Wastage in Imported Feed Systems**

Feed Delivered	System Used	Waste
Round bale hay	Ring feeders <sup>1</sup>	3 - 15%
	Processed onto snow <sup>2</sup>	19.2%
	Unrolled onto snow <sup>2</sup>	12.3%
	Bale processor into portable bunk <sup>2</sup>	0%
	Bale grazing	15 - 20%
Round bale silage	Processed onto snow <sup>2</sup>	23.2%
Pit silage*	Delivered onto snow <sup>2</sup>	26.8%*
	Delivered into portable bunk <sup>2</sup>	0%

\* Feeding rate for the pit silage was 25% lower than round bale silage on a dry matter basis.

As a result, the total amount of waste could be significantly higher for chopped pit silage compared to processed round bale silage

1. Buskirk D.D., Zanella A. J., Harrigan T. M., Van Lente J. L., Gnagey L. M., Kaercher M. J. 2007. Large round bale feeder design affects hay utilization and beef cow behavior. *J. Anim. Sci.* 81:109-115.
2. Yarencio B. J., 2009 Determining the nutritional and economic impact of feed waste when wintering beef cows in Central Alberta. University of Alberta Press. Edmonton, Alberta

### Feeding Silage:

Silage is a higher moisture forage (30 to 70% moisture content) that has fermented in storage, such as a tower silo, silage pit, or round bale silage (tubes or individually wrapped), to maintain feed quality so it can be fed at a later date.

- Nutrient accumulation per acre can be as high as or higher than what is experienced with bale grazing or unrolled/processed hay.
- The use of portable bunk feeders or inverted tires is recommended to reduce waste where applicable to the silage feeding system being used. Moving these portable feeders on a regular basis or spacing them farther apart is recommended to more evenly distribute the nutrients.
- As silage particle size becomes smaller, the amount of feed waste increases. Silage waste can vary from 25% to as high as 35%.
- If nutrient hot spots occur, they will exceed the nutrient requirements of the subsequent crop, increasing the risk of nutrient movement into water sources.



Photo: Garth Mottershead - AAFC

## Feeding Intensity

Feeding intensity, or cow days per acre, refers to the number of animals fed for a specified period of time in a certain area. Nutrient loading increases with feeding intensity.

To calculate feeding intensity:

A. How many cows will be fed? 100

B. How many days will these cows be fed within this field? 90

C. How many acres will be used to feed these cows during this time? 80

(Acres are based on the size of the field in which the livestock have access to)

D. Cow days per acre = 112

(A X B / C)

$$100 \times 90 / 80 = 112$$

Table 3 identifies the environmental risk levels for various feeding intensities, assuming all other factors are equal.

Table 3. Environmental Risks and BMPs Related to Feeding Intensity on Wintering Site Field

Percent of field which is the feeding area in 1 year	Cow Days per Acre/ Environmental Risk Level				Potential Concerns	Beneficial Management Practices
	<250	250 – 500	500 – 1000	1000 – 1500		
Most or all of the field	✓				Higher feeding intensities generate higher amounts of manure nutrients.	If possible, reduce cow days per acre to yellow or green risk levels. This can be achieved by: <ul style="list-style-type: none"> <li>• reducing the number of days animals are fed at the site,</li> <li>• increasing the size of the feeding area, or</li> <li>• reducing the number of animals fed at the site.</li> </ul>
About half of the field						
Less than a third of the field (See illustrations on page 24)						

Note: It is recommended to never exceed 1500 cow days per acre. Corresponds to over 50 bales per acre relating to approximately 1000 lbs/ac of N and 150 lbs./ac of P<sub>2</sub>O<sub>5</sub>.

# Nutrient Levels in Feed, Feed Wastes, and Manure

## Feed Requirements and Nutrient Deposition

The amount of feed required to overwinter cattle is, of course, a crucial consideration for cattle health, but it also affects the nutrient loading on the wintering site. Table A1 in the Appendix provides a procedure for estimating the amount of feed required, taking into account animal nutritional requirements and feed wastage. It also shows how to calculate the amount of nitrogen (N) and phosphorus (P) that will be deposited at the site.

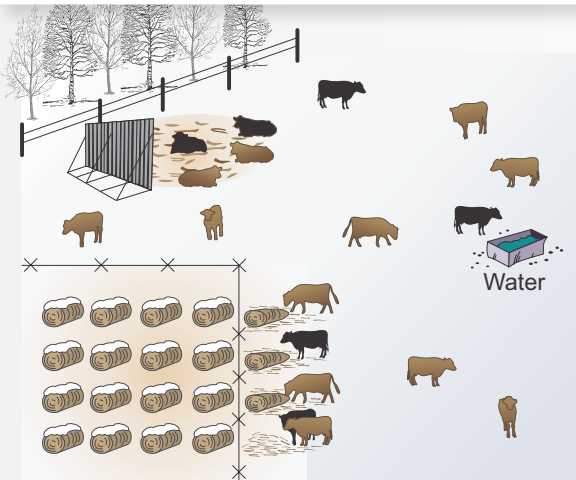
Approximately 70 to 90% of the nutrients consumed by ruminants are excreted. For example, cattle are very inefficient consumers of protein (nitrogen) and phosphorus, utilizing only 7 to 10% of the nitrogen and 15% of the phosphorus supplied in the feed. Nitrogen retention in soil is higher when manure is excreted directly onto the land rather than in a confined area and hauled out to the field.

### Example of calculations for nutrients deposited from winter feeding:

When a forage ration is fed to a 1400-pound cow for 150 days, up to 1920 lb of dry manure can be produced (12.8 lb/day).

Nutrients excreted are approximately 78.7 lb of total nitrogen and 19.4 lb of phosphorus per head for that time period.

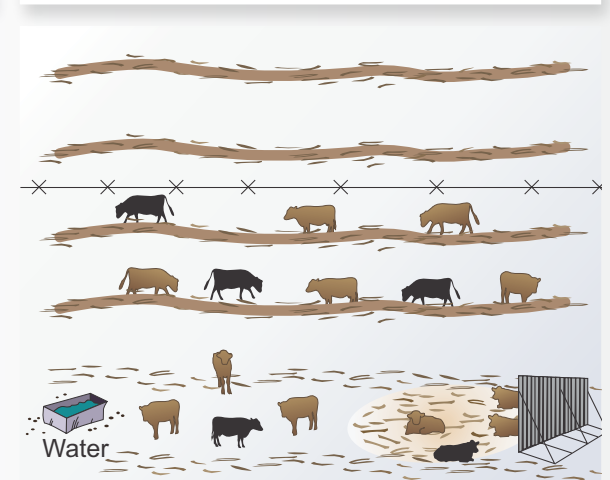
Less than 1/3 of the field



50% of the field



More than 50% of the field





## Nutrient Density in Feed

Table 4 lists the approximate amount of feed per acre and the amounts of nitrogen and phosphorus deposited in manure and feed wastes from various feeding strategies.

*Table 4. Approximate Densities and Nutrient Deposits for Various Feeding Strategies on One Acre*

Feeding Strategy	Feed Density per acre	Cow Days per acre	Nitrogen per acre* <sup>1</sup> Available Nitrogen 1st yr.	P <sub>2</sub> O <sub>5</sub> per acre <sup>2</sup> Available P205 1st yr.	Available Nutrient Value 1st yr per acre*
Bale grazing	25 bales weighing 1300 lbs	844	572 lb/ac 172 lb/ac = \$102.96/ac	112 lb/ac 56 lb/ac = \$31.82	\$134.78
Processed or unrolled bales	5 bales of 1300-lb bales	169	114 lb/ac 34 lb/ac = \$20.59/ac	22 lb/ac 11 lb/ac = \$6.36	\$26.96
Standing corn grazing	4.5 tons	234	158 lb/ac 48 lb/ac = \$28.51/ac	31 lb/ac 15 lb/ac = \$8.81	\$37.32
Swath grazing annual crops	2.25 tons	117	79 lb/ac 24 lb/ac = \$14.26/ac	15 lb/ac 8 lb/ac = \$4.41/ac	\$18.66
Stockpiled perennial forages	1.5 tons	78	53 lb/ac 16 lb/ac = \$9.50/ac	10 lb/ac 5 lb/ac = \$2.94/ac	\$12.44
Feeding annual crop residues	1 ton	52	35 lb/ac 11 lb/ac = \$6.34/ac	7 lb/ac 3 lb/ac = \$1.96/ac	\$8.29

Note: All of the above examples assume a 1400-lb cow and feed with 11% protein and 0.15% phosphorus content. Actual densities and nutrient deposits may vary considerably depending on numerous factors.

\* Prices of nitrogen and phosphorus are based on the 5-yr averages for 2007 to 2012 : average price of nitrogen (46-0-0) is \$604.05/T (\$0.60/lbs.); and average price of P<sub>2</sub>O<sub>5</sub> is \$798.14/T (\$0.57/lbs.); Alberta Agriculture Statistics.

<sup>1</sup> Available nitrogen in the first year; approximately 30% of total nitrogen depending on numerous factors.

<sup>2</sup> Available P<sub>2</sub>O<sub>5</sub> in the first year; approximately 50% of total P<sub>2</sub>O<sub>5</sub>.

**For example, in bale grazing with 25 bales placed per acre, there will be sufficient feed to provide 844 cow days per acre; estimated to leave approximately 572 lb/ac of nitrogen and 56 lb/ac of phosphorus at the feeding area. This can be compared to a swath grazing system that would supply enough feed for 100 cow days per acre and nutrient deposits of 66 lb/ac of nitrogen and 13 lb/ac of phosphorus.**

**Knowing the nutrient content of different feed sources and adjusting feeding strategies and volumes (tonnes/acre) accordingly will help to minimize the risk of accumulating nutrients, while providing sufficient nutrients for the herd.**

Table 5 shows the calculations to estimate the amount of nitrogen and phosphorus supplied in a hay bale and the value of those nutrients.

*Table 5. Estimating Amount and Value of Nitrogen and Phosphorus Supplied per Bale*

<b>Nitrogen amount</b>	% Crude protein ÷ 6.25	X	Bale weight (lb)	=	Nitrogen (lb/bale)
Example: 11% crude protein	0.11 ÷ 6.25	X	1300 lb	=	22.88 lb N/bale
<b>Nitrogen value</b>	Value of Nitrogen/lb	X	Nitrogen (lb/bale)	=	Value of Nitrogen/bale
Example: Value of N = \$0.60/lb	\$0.60/lb	X	22.88 lb/bale	=	\$13.72/bale
<b>Phosphorus amount</b>	% Phosphorus	X	Bale weight (lb)	=	Phosphorus (lb/bale)
Example: 0.15% Total P (= 0.0015 Total P)	0.15% or 0.0015	X	1300 lb	=	1.95 lb of P/bale
	Convert Total P to fertilizer equivalent Total P x 2.29 = P <sub>2</sub> O <sub>5</sub>		Amount of P <sub>2</sub> O <sub>5</sub> /bale = 1.95 lb x 2.29	=	4.45 lb P <sub>2</sub> O <sub>5</sub> /bale
<b>Phosphorus value</b>	Value of P <sub>2</sub> O <sub>5</sub> /lb	X	Amount of P <sub>2</sub> O <sub>5</sub> /bale	=	Value of P <sub>2</sub> O <sub>5</sub> /bale
Example: Value of P <sub>2</sub> O <sub>5</sub> = \$0.57/lb	\$0.57/lb	X	4.45 lb/bale	=	\$2.53/bale

**Total value  
of nutrients in bale  
= Value of N/bale  
+ Value of P<sub>2</sub>O<sub>5</sub>/bale  
= \$xxx/bale**

**Example:  
\$13.72/bale  
+ \$2.53/bale  
= \$16.25/bale**

## Frequency of Use of Feeding Areas

Rotating of wintering sites provides the most economical return to the producer, allowing the crop to make use of the available nitrogen each year while reducing the potential for nutrients to build up over time and be at risk of leaching or being transported in runoff from the site. Even if it's not possible to rotate the wintering site location, it's important to rotate the location of the feeding area within the wintering site from one year to the next.

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**The importance of rotating the location of winter feeding from year to year** is highlighted in a Western Beef Development Centre study which found only 20% of the total nitrogen load is available for uptake by the crop in the year following winter feeding.

(B.Kelln, H.A. Lardner, J.Schoenau, J.McKinnon, J.Campbell, and K.Lang)

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Photo: Linda Pierson

## Environmental Risks and BMPs Related to Frequency of Feeding Area within a Wintering Site

Table 6a. Imported Feeds

Feeding Strategy	Feeding Frequency/ Environmental Risk Level				Potential Concerns	Beneficial Management Practices  *BMP's will depend on the type of Feeding Strategy
	Every year	Once every 2 to 3 years	Once every 3 to 4 years	Once every five years (bale razing only)		
Unrolling or processing hay Bale feeders Feeding silage				N/A	<p>Imported feeding systems have a high potential for nutrient accumulation.</p> <p>Continued use of the same site for imported feeding systems further increases the risk of excessive nutrient levels.</p>	<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: red; border-radius: 50%; margin-right: 5px;"></span> Manage site run-on and runoff to reduce the risk to surface water sources.</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: white; border: 1px solid gray; border-radius: 50%; margin-right: 5px;"></span> Place bales, feed / bunks away from the path of runoff.</li> </ul>
Bale grazing					<p>Imported feeding system, bale grazing has a high potential for nutrient accumulation.</p> <p>The spacing of bales affects the concentration and the distribution of nutrients deposited across the field. The closer the spacing, the higher the potential for nutrient hot spots.</p> <p>Continued use of the same site for bale grazing further increases the risk of excessive nutrient levels.</p>	<p>Manage placement of portable feeders and processed bales or feed, or whole bales to evenly distribute nutrients. Soil test to identify nutrient-deficient areas, and use those areas for feeding. Soil testing can also be used to identify areas high in nutrients so they can be avoided during subsequent feedings.</p> <p>Use portable shelters, and move them frequently. Move bedding areas frequently.</p>

**It is recommended for imported feeding systems that the feeding area within the wintering site be used less than once every three years to minimize the risk of nutrient accumulation and nutrient leaching and runoff losses.**



Table 6b. Non Imported Feeds

Feeding Strategy	Feeding Frequency/ Environmental Risk Level			Potential Concerns	Beneficial Management Practices  *BMP's will depend on the type of Feeding Strategy
	Every year	Once every 2 to 3 years	Once every 3 to 4 years		
Swath grazing Grazing annual crop residues Grazing stockpiled forages				Continued use of the same site year after year can result in build-up of excess nutrients.  For any type of non-imported feeding system, there is potential for nutrient accumulation in shelter, bedding, and watering areas if site is used repeatedly.	Manage site run-on and runoff to reduce the risk to surface water sources.  Match crop nutrient requirements to soil nutrient levels based on soil test and fertilizer recommendations.
Corn grazing				Corn grazing adds more nutrients to the site than lower-input non-imported feeds.  Corn requires higher fertilizer application rates to optimize yield compared to annual cereal or forage crops, so the risk of nutrient accumulation is greater. Corn has high dry matter yields so corn grazing usually requires a higher feeding intensity (cow days per acre) than other types of non-imported feeding systems. As a result, more manure and feed wastes accumulate on corn grazing sites. Continued use of the same site year after year can result in build-up of excess nutrients. For any type of non-imported feeding system, there is potential for nutrient accumulation in shelter, bedding, and watering areas if site is used repeatedly.	Use portable shelters and move them frequently.  Move bedding areas frequently.  Manage access to feed using an electric fence to reduce feed wastes and evenly distribute nutrients.

# Flooding

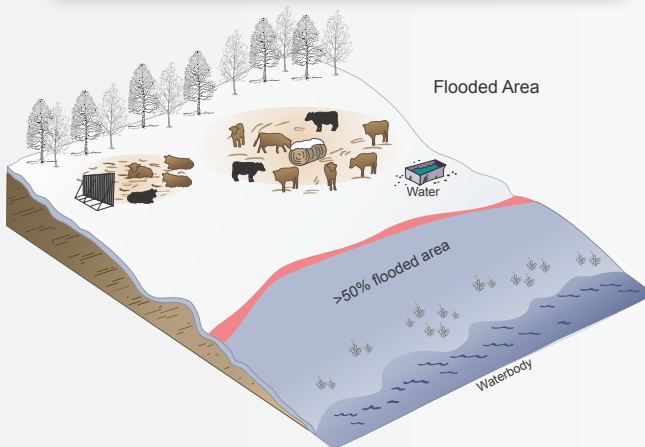
If possible, wintering sites should not be located on lands that are frequently subject to short-duration flooding caused by spring runoff, heavy rains and/or overflowing rivers or streams. If such lands must be used, they require careful management during and after winter feeding.

The length of time a wintering site is flooded depends on the volume of the flow, existing soil saturation levels, depth of water table, soil texture, slope, and weather conditions during the time of the flood. During periods of flooding, nutrients, pathogens and sediments may be directly transported to surface waters.

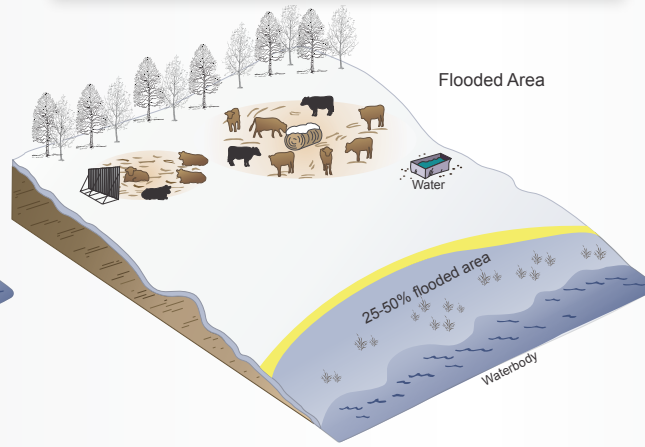
Table 7 on pg 31 identifies flooding-related environmental risks and associated BMPs, based on the type of feeding system. Non-imported feed refers to an annual or perennial crop that is grown and consumed on the same site. Imported feed refers to feed that is hauled

to the site from other locations. Imported feeding systems tend to add more nutrients to the site than non-imported feeding systems and they have a greater risk of localized concentrations of nutrients (see the Feeding Systems Table 7 for more information). Higher nutrient accumulations increase the risk of nutrients moving from the site into water sources.

> 50% Flooded Area



25-50% Flooded Area



0-25% Flooded Area

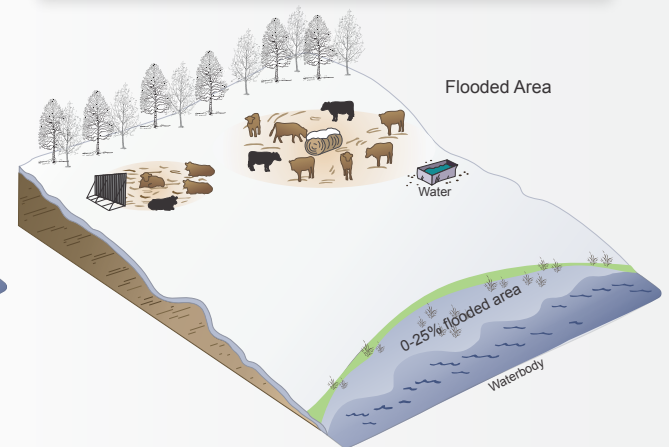






Table 7. Environmental Risks and BMPs Related to Flooding of Wintering Sites

Flood Extent	Feeding System	Flooding Frequency/ Environmental Risk Level		Potential Concerns	Beneficial Management Practices
		1 - 3 years	4 - 10 years		
>50% of field	Imported feed			The larger the flooded area and/or the greater the flooding frequency, the greater the risk of nutrients and pathogens being carried into surface waters.	<ul style="list-style-type: none"> <li> Select a different site or divert water inflow to reduce the flooded area or the frequency of flooding.</li> <li> Avoid placing feeding, watering, bedding, and sheltering areas in the flood-prone portion of the field.</li> <li> Maintain a buffer zone between the feeding area and the flood-prone area. Decrease feeding intensity by reducing cow days/ac. For imported feed, avoid using the site if the soil conditions are wet prior to winter freeze-up. For non-imported feed, monitor conditions, and be ready to implement emergency measures to prevent site runoff from entering waterbodies. Divert water inflow to reduce the flooded area or the frequency of flooding. If possible, place feed, bedding, shelter, and watering areas away from areas with sandy and/or gravelly soils, or high water tables.</li> <li> Decrease feeding intensity during wet climate cycles.</li> </ul>
	Non-imported feed				
25 - 50% of field	Imported feed			The risk of nutrient transport by flood water is higher for imported feeds because they tend to add more nutrients to the site than non-imported feeds.	
	Non-imported feed				
0 - 25% of field	Imported feed				
	Non-imported feed,				

## Runoff

Preliminary research findings have indicated that there is a high potential for nutrients to be transported during snowmelt runoff from wintering sites. This transport often happens despite the presence of vegetative buffers.

Dormant or dead plants provide minimal biological uptake of dissolved nutrients in the runoff, and they tend to be less effective at slowing down water flow under frozen soil conditions, so they trap less sediment and nutrients.

The potential concerns for the various extensive feeding systems and the BMPs to address these concerns depend primarily on whether runoff leaves the wintering site (Table 8 on pg 33) or is contained on the site (Table 9 on pg 34).



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**Ensure you know where your runoff is flowing**  
Is the runoff leaving the wintering site  
or is it contained within?

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Table 8. Environmental Risks and BMPs Related to Runoff Leaving Wintering Site

Feeding Method/ Environmental Risk Level	Potential Concerns	Beneficial Management Practices
Imported feed	<p>Increased nutrient loading from imported feed greatly increases the risk of transport of nutrients and pathogens by runoff. This risk is even greater when combined with high stocking rates.</p>	<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: red; border-radius: 50%; margin-right: 5px;"></span> Install water control structures such as berms, ditches, and catch basins to prevent contaminated runoff from leaving the site or entering surface water sources.</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: gray; border-radius: 50%; margin-right: 5px;"></span> Move feed bunks or round bale feeders.</li> <li>Reduce feeding intensity.</li> </ul> <p>Note: Consult with provincial authorities for approved design and layout to divert or the catchment of runoff water prior to installation.</p>
Non-imported feed	<p>High-input crops such as corn require higher amounts of fertilizers and pesticides, so corn grazing has a relatively high potential for contaminated runoff. Corn also has high dry matter yields so corn grazing usually requires a higher feeding intensity (more cow days per acre), resulting in more manure and feed wastes in comparison to lower-input non-imported feeds.</p> <p>Even for lower-input non-imported feed, there is still some risk of contaminated runoff from bedding and watering areas.</p>	<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: red; border-radius: 50%; margin-right: 5px;"></span> Place feed, bedding, shelter, and watering areas away from runoff pathways or in locations with no runoff into surface water sources.</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: yellow; border-radius: 50%; margin-right: 5px;"></span> Place a vegetative buffer along waterways and the edges of waterbodies to trap nutrients, pesticides, and sediments before fall freeze-up and after spring thaw.</li> </ul>

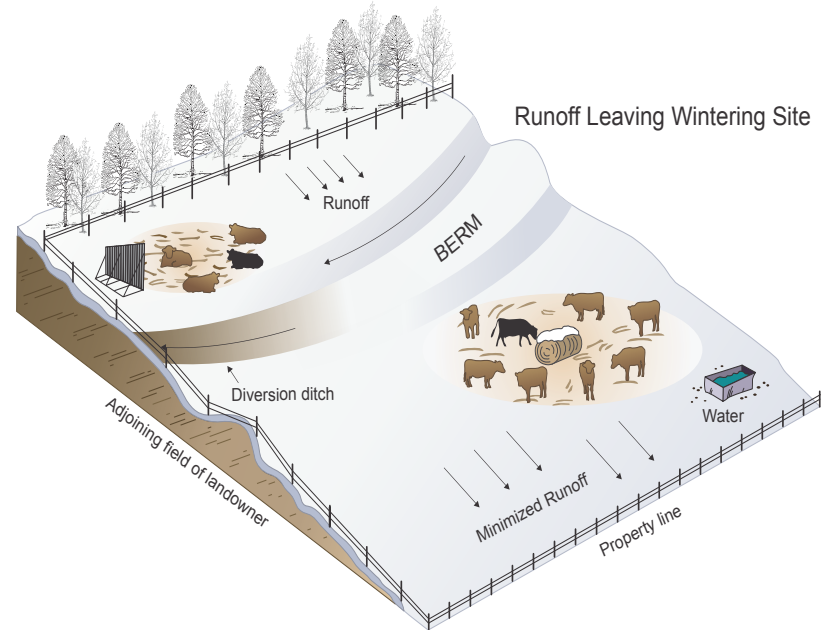
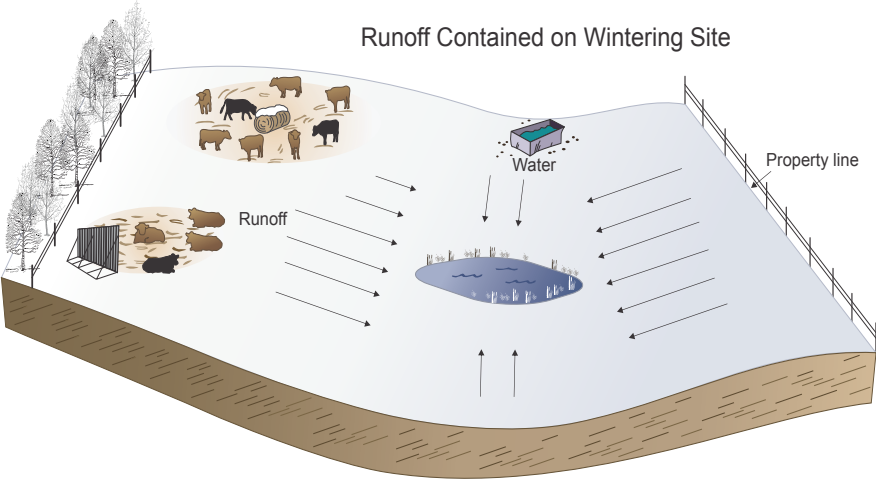


Table 9. Environmental Risks and BMPs if Runoff is Contained on Wintering Site

Feeding Method/ Environmental Risk Level	Potential Concerns	Beneficial Management Practices
Imported feed	<p>Although the risk to surface water quality is less when runoff is contained on the site, nutrients still have the potential to move into groundwater sources.</p> <p>Every waterbody will overflow upon reaching full capacity, increasing the risk of the runoff leaving the site.</p> <p>Runoff containment area may result in poor water quality and would be unproductive as a water source for livestock.</p>	<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: red; border-radius: 50%; margin-right: 5px;"></span> Monitor the waterbody during very wet conditions. If necessary, be ready to take emergency measures to prevent the water from flowing offsite.</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: white; border-radius: 50%; margin-right: 5px;"></span> Reduce feeding intensity, cow days per acre, if environmental risk is high.</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: white; border-radius: 50%; margin-right: 5px;"></span> Fence the waterbody to prevent direct access by cattle.</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: yellow; border-radius: 50%; margin-right: 5px;"></span> Harvest the annual crop or forage crop around the waterbody to utilize some of the nutrients.</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: green; border-radius: 50%; margin-right: 5px;"></span> Place feed, bedding, shelter, and watering areas away from runoff pathways.</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: white; border-radius: 50%; margin-right: 5px;"></span> Move feeding areas frequently.</li> </ul>
Non-imported feed high input crop	<p>Corn grazing adds more nutrients to the site than grazing of lower input crops. Other high-input crops such as crops grown under irrigation may also have the same concerns.</p>	
Non-imported feed, medium and low-input crop	<p>For lower-input non-imported feeds, the risk of nutrient accumulation is low. The more extensive feeding systems force the animals to move around the site, distributing manure across the site, so the amount of manure exposed to runoff channels may be reduced. Losses to leaching are lower as long as subsequent crops are managed based on a recommended fertility management plan.</p>	



## Bedding and Shelter Management

Nutrient accumulation at shelter and bedding areas can be significant. Providing bedding and shelter over a greater area or regularly moving bedding and shelter areas spreads the nutrients more uniformly across the site and prevents nutrient hot spots. More uniform nutrient distribution reduces environmental risks and allows subsequent crops to take better advantage of the nutrients, reducing fertilizer costs.

Photo: Dale Timmerman AAFC

## Types of Shelter

Ensuring livestock have adequate shelter during extensive winter feeding is critical to both livestock welfare/health and protecting the environment. A backup plan is essential in case conditions change and the initial shelter becomes inadequate. Determine what shelter alternatives are available, and develop a plan for implementing the preferred alternative if needed.

Shelters may be natural, portable or fixed. Each type has its advantages and disadvantages. The potential for environmental concerns depends on the shelter type and livestock access (Table 10). In uncontrolled access, the cattle can directly enter the shelter area. Fencing can be used to prevent livestock access.



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### “How often to move your portable windbreaks?”

If 120 cows spend 4 hours per day for 11 days behind a portable windbreak with a total length of 120ft, the amount of nutrients deposited would be equivalent to 998 cow days per acre. To be environmentally and economically feasible this producer should move the portable windbreaks every two weeks. (Saskatchewan Water Security Agency, 2012)

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Table 10. Environmental Risks and BMPs Related to Shelter Type

Type of Shelter	Livestock Access/ Environmental Risk Level	Potential Concerns	Beneficial Management Practices
Bush/forested (natural) areas Shelterbelts	Uncontrolled access	<p>Browsing and trampling by livestock can cause degradation of the understory, shelterbelt, habitat loss, and reduced protection for crops from wind, etc.</p> <p>Cattle tend to linger in sheltered areas, resulting in nutrient build-up.</p> <p>Bush / forested area may be surrounding a wetland or waterbody. (See riparian area)</p>	<ul style="list-style-type: none"> <li>• Shorten the time livestock have access to the area.</li> <li>• Provide portable windbreaks to minimize the time livestock spend in the natural area.</li> <li>• Feed and water cattle further away from the natural area.</li> <li>• Monitor access and browsing pressure, and reduce access as needed.</li> <li>• Fence trees to protect understory.</li> </ul>
Treed fencelines	Perimeter fenced	Cattle tend to linger beside sheltered areas, resulting in nutrient build-up alongside the shelterbelt.	<ul style="list-style-type: none"> <li>• Maintain natural shelter without browsing and negatively impacting the woody habitat. Provides safe haven for wildlife.</li> <li>• Provide portable windbreaks to minimize the time livestock spend in the natural sheltered area.</li> <li>• Feed and water cattle further away from the natural sheltered area</li> </ul>

Table 10. Environmental Risks and BMPs Related to Shelter Type

Type of Shelter	Livestock Access/ Environmental Risk Level	Potential Concerns	Beneficial Management Practices
Riparian areas	Uncontrolled access	Livestock tend to linger in riparian areas, resulting in manure build-up, and degradation of riparian function, degradation of understory, habitat loss and potential decreased water quality.	<ul style="list-style-type: none"> <li>• Locate feeding and bedding sites away from riparian area,</li> <li>• Provide an adequate distance between riparian area and feeding /watering area to minimize impact.</li> <li>• If necessary, fence riparian area to protect vegetation and water quality.</li> </ul>
	Riparian area is fenced off from livestock access.	Cattle tend to linger near riparian areas, resulting in manure and nutrient build-up.	<ul style="list-style-type: none"> <li>• Monitor manure deposition near riparian area, to avoid excessive buildup</li> <li>• Provide feed, water and/or alternate shelter further away from riparian area.</li> </ul>
Portable shelters/ windbreaks	Portable shelters are NOT moved	<p>Portable shelters/windbreaks will encourage excessive manure and nutrient build-up if not moved.</p> <p>Snowdrifts may make the portable shelter ineffective.</p>	<ul style="list-style-type: none"> <li>• Move shelters and windbreaks periodically to prevent excessive manure and nutrient build-up.</li> </ul>
	Portable shelters are moved at least once per month or when excess manure build-up is evident	Cattle tend to linger in sheltered areas, resulting in manure and nutrient build-up.	
Permanent shelters/ windbreaks		<p>Cattle tend to linger in shelters, resulting in manure and nutrient build-up.</p> <p>Permanent shelters / windbreaks tend to encourage manure and nutrient build-up over time.</p>	<ul style="list-style-type: none"> <li>• Remove excess manure and spread on the field in the spring.</li> <li>• Provide alternate bedding areas (e.g. use portable shelters or distribute straw bales at various locations in the wintering site).</li> </ul>



Photo: Dennis Lastuka, AAFC

## Water Source Management

Ensuring livestock have a clean, secure source of water is critical both to livestock welfare/health and protection of the environment. The main types of water sources available for wintering sites include wells, springs, dugouts, natural waterbodies, and snow. Each one of these sources has advantages and disadvantages. Table 11 identifies the BMPs for dealing with the potential environmental risks for these different water sources.

When livestock have direct or uncontrolled access to a waterbody, the cattle can directly enter the waterbody from any point. This type of access has the highest potential for water quality degradation, from animals defecating directly into the water and trampling (pugging and hummocking) the banks of the water source, contributing to sedimentation and bank instability.

Controlled access means that livestock can directly enter the waterbody at only one 'controlled' point; access is usually controlled with fencing. This type of access also has a potential for water quality degradation, although damage to the banks is limited to a relatively small area. Offsite watering involves the transfer of water from the water source into troughs, keeping the water source safe from contamination by livestock.

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**It is crucial to always have a backup plan for water at wintering sites in case the initial selection for a water source is unavailable. Assess what would happen if the water source was not available, determine what alternatives exist, and develop a plan for implementing the preferred alternative if needed.**

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For example, if snow is the main water source, what would happen if no snow was available? If a well is the main water source, what would happen if the well failed?



Photo: Jeannette Greaves

Table 11. Environmental Risks and BMPs Related to Watering Source

Type of Water Source	Livestock Access/ Environmental Risk Level	Potential Concerns	Beneficial Management Practices
Water Well	Trough <100 ft from well or upslope of well	<p>Potential well contamination can occur if manure accumulates around the trough site.</p> <p>Trampling by cattle can cause soil degradation and damage around the trough and well structure.</p> <p>If the trough is upslope of the well, runoff could carry nutrients and pathogens toward the well. If the well is not properly sealed or excessive volumes of runoff occur, the well is at risk of contamination.</p>	<ul style="list-style-type: none"> <li>• Ensure proper well structure, well-cap, and well sealing, etc.</li> <li>• Place the trough downslope of the well in an exposed area away from feed and bedding areas to reduce loafing and nutrient accumulation if possible.</li> <li>• Fence off surface components of well structure.</li> <li>• Divert run-on away from well.</li> <li>• Place feeding, bedding, and shelter areas downslope of the well.</li> </ul>
	Trough >100 ft from well or downslope of well	<p>Manure and nutrient accumulation can occur due to cattle resting around trough area.</p> <p>Trampling by cattle can cause degradation of the trough site.</p> <p>If the trough is upslope of the well, runoff could carry nutrients and pathogens toward the well. If the well is not properly sealed or excessive volumes of runoff occur, the well is at risk of contamination.</p>	<ul style="list-style-type: none"> <li>• Fence off surface components of well structure.</li> <li>• Ensure proper well structure, well-cap, and well sealing, etc.</li> </ul>



Table 11. Continued

Type of Water Source	Livestock Access/ Environmental Risk Level	Potential Concerns	Beneficial Management Practices
Spring	Uncontrolled access	Trampling by cattle can cause degradation of the spring. Contamination of the spring with manure and nutrients can occur.	<ul style="list-style-type: none"> <li>• Develop and fence spring, providing water to a trough. Place trough downslope from spring, in an exposed area, away from the path of runoff, and away from feed and bedding.</li> </ul>
	Developed and fenced	Nutrient accumulation can occur around the trough area.	<ul style="list-style-type: none"> <li>• Place trough downslope from spring, in an exposed area, away from the path of runoff, and away from feed and bedding.</li> </ul>
Dugout	Uncontrolled access Controlled access	Trampling by cattle can cause degradation of the dugout structure, i.e. side sloping of banks. Contamination of the dugout with nutrients and pathogens can occur. Water supply requires daily attention (chopping ice). Potential exists for cattle to break through the ice.	<ul style="list-style-type: none"> <li>• Eliminate direct access by fencing perimeter of the dugout.</li> <li>• Develop offsite watering downslope from the dugout.</li> <li>• Place feeding and bedding areas downslope from the dugout.</li> </ul>
	Offsite watering	Trampling by cattle can cause degradation of the trough site. Nutrient accumulation can occur at the trough site. Contamination of the dugout by manured runoff from the trough site can occur, especially if the dugout is downslope of the trough.	<ul style="list-style-type: none"> <li>• Place trough as far as possible from waterbody, in an exposed area, and away from feed and bedding.</li> </ul>

Table 11. Continued

Type of Water Source	Livestock Access/ Environmental Risk Level	Livestock Access/ Environmental Risk Level	Beneficial Management Practices
Natural Water Body	Uncontrolled access	Trampling by cattle can damage the banks of the waterbody. Cattle may contaminate water with nutrients and pathogens. Water supply requires daily attention (chopping ice). Potential exists for cattle to break through ice. The waterbody may not be a reliable water source.	<ul style="list-style-type: none"> <li>• Eliminate direct access by fencing perimeter of the waterbody.</li> <li>• Allow access to natural waterbody when the soils are least sensitive to trampling (pugging and hummocking).</li> </ul>
	Controlled access	Same as above, except damage to the banks is limited to the access point.	
	Offsite watering	Trampling by cattle can cause degradation of the trough site. Nutrient accumulation can occur at the trough site. Contamination of the water source by runoff from the trough site may occur, especially if the waterbody is downslope of the trough.	<ul style="list-style-type: none"> <li>• Ensure manured runoff drains away from the dugout (e.g. install berms or ditching).</li> <li>• Place trough as far as possible from waterbody, in an exposed area, and away from feed and bedding.</li> </ul>
Snow	Free choice	Snow is not always reliable as water source (e.g. not enough volume, crusting). Snow can be a management concern regarding animal health.	<ul style="list-style-type: none"> <li>• Ensure adequate supply of clean, soft snow is always available and have a backup water source.</li> </ul>



Photo: Culliford

## Post-Wintering Site Management

After a winter feeding season, any areas with a build-up of manure and residual feed may need to be addressed before the growing season gets underway. Management will need to be tailored to the land use the following year.



**Any areas with excessive manure build-up will need to be addressed before the growing season gets underway. In larger feeding and bedding pack areas, the manure and feed wastes can be stockpiled and then spread across the site. Producers could consider harrowing to spread manure and feed wastes more evenly on perennial forage lands. For annual crops, a pass or two with a heavy harrow or cultivator may be needed before seeding.**

Soil erosion issues may occur on the site depending on such factors as soil type, site slope, livestock density, run-on water and weather events. To reduce erosion, ensure that adequate vegetative cover is maintained. Grassed waterways or healthy vegetative buffers along riparian zones will also greatly reduce erosion issues.

As noted earlier, rotation of wintering sites from year to year is essential. Soil test results can be used to develop a wintering site rotation plan that will optimize crop use of available nutrients while minimizing the need for fertilizer applications or for removing and reseeding unproductive pasture. Rest periods of three to four years are recommended on wintering sites where feed is imported. Longer delays should occur in situations where soil nutrient levels are high and where large amounts of residue remain.







# Summary

**A wintering site needs to be selected and managed to meet cattle requirements for nutrients, water, bedding, and shelter. For the winter feeding system to be sustainable, environmental risks must also be addressed.**

The greatest environmental risk from wintering sites is the potential for water contamination from runoff carrying nutrients, pathogens and sediments. Also, excessive nitrogen levels in the soil at the site increase the risk of nutrients leaching into groundwater sources. Elevated soil nutrient levels can result in subsequent crop production concerns such as lodging or high feed test nitrate-nitrogen levels. Elevated soil nitrogen levels combined with high soil moisture conditions can result in gaseous losses of nitrogen, and ammonia emissions from manure may cause odour concerns.

When nutrients are lost from the wintering site system into the environment, the potential economic benefits of those nutrients for subsequent crops is also lost.

The environmental risk levels of wintering sites are influenced by several factors including: site characteristics, feeding strategies, bedding and shelter management, management of water sources, and management of the site after the wintering season.

The Wintering Site Assessment and Design Tool can be used to evaluate the environmental risks for specific situations and to identify possible BMPs to reduce these risks and increase the potential for economic benefits from winter feeding.

Selecting a site based on soil, slope, and water flow characteristics can help reduce environmental risks associated with managing manure and nutrients

on the site. While producers can't control all site characteristics, various BMPs are available to decrease risk levels.

Imported feeding systems, such as bale grazing, have the potential to add a significant amount of nutrients to the site, increasing the risk of nutrient loss to the environment. On the other hand, imported feeding systems can be a good choice to help build soil quality at nutrient-deficient sites, if the potential for nutrient loss is reduced or eliminated. Practices like moving portable feeders and evenly spacing bales across the site for bale grazing help spread manure and feed wastes across the site and prevent nutrient hot spots. More uniform nutrient distribution is better for the performance of subsequent crops and helps reduce environmental risks associated with nutrient movement.

Non-imported feeding systems have a lower risk of nutrient build-up. Practices like using a portable electric fence to limit cattle access to a small portion of the field at a time help reduce feed wastes.

Moving bedding and portable shelters is another way to encourage cattle to use more of the wintering site and prevent nutrient hot spots. If natural areas, like forests or riparian areas, are used for shelter, then producers need to monitor livestock impacts, such as browsing pressure, to ensure the natural area remains able to perform functions like providing wildlife habitat, protecting water quality, and so on.

Developing offsite watering systems and fencing water sources help protect water supplies from manure contamination. Placing water troughs in exposed areas and away from feeding and bedding areas helps prevent nutrient hot spots.

Producers need to visit their wintering sites frequently to ensure the cattle always have adequate feed, shelter, bedding, and water. Having backup plans for an alternative water source and an alternative shelter is important in case adverse conditions occur.

After a winter feeding season, any areas with a build-up of manure and residual feed may need to be addressed before the growing season gets underway.

Rotation of winter feeding sites is essential because using the same site year after year can lead to excessive nutrient build-up. Rest periods of three to four years are generally recommended for imported feeding systems before using the same feeding area again. Longer delays are needed if soil tests show that the area's nutrient levels remain high.

With proper site selection and management, winter feeding can save money during the wintering season, decrease fertilizer costs and increase yields for the subsequent crops, and reduce risks to the environment.

# Definitions

## *Beneficial Management Practice*

A management practice that reduces or eliminates an environmental risk. BMPs are site-specific practices that take into consideration legislation, practicality, and operational needs for a specific operation within a specific geographical area.

## *Berm*

A berm is a constructed earthen wall that is used to direct water flow away from sensitive areas.

## *Catch Basin*

An excavation with bermed sides that is designed to collect and store runoff.

## *Controlled Access to Waterbody*

Animals are restricted, usually by a fence, to only access the waterbody at one point.

## *Direct Access*

see *Uncontrolled Access to Waterbody*.

## *Extensive Wintering Site*

An area of land used for winter feeding in which livestock have the ability to move about without restriction. The site includes the feeding, bedding, and watering areas plus the remaining areas the cattle have access to.

## *Feeding Area*

The ground space within which feed is distributed. This area may include many acres in a swath grazing system, for example, or limited acreage in a bale feeder or trough system.

## *Grassed Waterway*

A wide, shallow grassed channel that can carry a large volume of water quickly down a steep slope without causing soil erosion.

## *High-Input Crop*

A crop, like corn, that requires relatively high inputs, such as fertilizer, to achieve optimum yields.

## *Imported Feed*

Forage or straw hauled from other locations to be consumed on the wintering site. This feed can also include grain, supplements, silage or any other types of feed that are imported to the feeding area.

## *Intensive Wintering Site*

A pen or confined area where animals are fed, bedded, and watered over the winter.

## *Leaching*

Movement of nutrients dissolved in water down through the soil profile and potentially into the groundwater.

## *Non-Imported Feed*

A forage or grain crop that is produced and consumed on the same parcel of land used as a wintering site.

## *Pathogen*

A disease-causing organism.

## *Riparian Area*

The zone along the edge of a waterbody or waterway. The land adjacent to streams, rivers, lakes, and wetlands, where the vegetation and soils are strongly influenced by the presence of water.

## *Sediment*

A naturally occurring material that is broken down by processes of weathering and erosion, and is subsequently transported by the action of wind, water, or ice, and/or by the force of gravity acting on the particle itself.

## *Sedimentation*

The tendency for soil and other particles in suspension to settle out of the fluid in which they are entrained, when the fluid flow slows or stops.

## *Stockpiled Forage Grazing*

Saving forage during the summer growth period for grazing when pasture growth normally slows or becomes dormant, usually in late summer, fall or early winter.

## *Uncontrolled Access to Waterbody*

Where livestock can enter a waterbody from any point; also known as direct access. This type of access has the highest potential for water quality degradation and bank erosion.

## *Vegetative Buffer*

A strip of vegetation that is intended to slow the movement of water and filter out nutrients and sediments from runoff. A permanent strip of vegetation, at least 10 ft wide, along the side of a watercourse, not including its associated growth.

## *Wintering Site*

A site where cattle are fed, watered, and sheltered during the winter. The site includes the feeding, bedding, and watering areas plus the remaining areas the cattle have access to.

# Resources

The [foragebeef.ca](http://foragebeef.ca) is a website for information for the Canadian forage and beef industry. It hosts a variety of information. The following documents can be found at [www.foragebeef.ca](http://www.foragebeef.ca)

## *Wintering Sites*

- Cattle Wintering Sites: Managing for Good Stewardship
- Livestock Wintering: Locating and Managing Your Site to Make it More Sustainable
- Stewardship and Economics of Cattle Wintering Sites
- Sustainable Management of Nutrients on the Landscape for In-field Livestock Winter Feeding Systems

## *Feeding Options*

### *Stockpiled Forages:*

- A Quick Guide to Extended Grazing
- Fall Pasture Management Tips
- Stockpiled Forages: A Way to Extend the Grazing Season

### *Swath Grazing:*

- Agronomic Management of Swath Grazed Pastures
- An Introduction to Swath Grazing in Western Canada
- Make It Work: Extending Alberta's Grazing Season
- Suitability of Cool and Warm Season Cereal Crops for Swath Grazing
- Swath Grazing Calculator

- Swath Grazing: Interesting Concept But Does it Pay?
- Swath/Windrow Grazing an Alternative Livestock Feeding Technique

### *Corn Grazing:*

- Grazing Cattle on Corn
- Using Corn to Extend the Grazing Season
- Comparison of Grazing Corn Varieties

### *Bale Grazing:*

- Bale Grazing
- Bale Grazing Calculator
- The Basics and Benefits of Bale Grazing

## *Windbreaks*

- Windbreaks Provide Shelter for Cattle

## *Water*

- Remote Winter Watering Systems for Beef Cattle

## *Fencing*

- 9 Winter Electric Fencing Tips

## *Other Resources:*

- Nutrient Management Calculator - AAFC
- Winter Grazing Options – Manitoba/AAFC
- Year Round Grazing 365 Days - AAFC
- Water Wells that Last For Generations - Alberta Agriculture and Rural Development
- Quality Farm Dugouts - Alberta Agriculture and Rural Development

## Appendix

Table A1. Steps in Estimating the Amount of Feed Required and the Amount of Nutrients Deposited on land for the Wintering Season

<p><b>Step 1. Calculate feed/day/animal</b></p> <p>Live weight of animal X Estimated feed intake/day (dry basis) = Amount of feed required/day/animal            Example: 1400 lb X 0.025 = 35 lb of feed (dry matter)/day/animal</p> <p style="text-align: right;">_____ lb x 0.025 = _____ (A)</p>
<p><b>Step 2. Determine hay/other forage equivalent</b></p> <p>Depends on moisture content, best determined through a feed analysis – could maybe use an average of 15% for hay            Example: Hay = 15% moisture content ; therefore 85% dry matter            35 lb (DM) hay divided by 0.85 = 41.2 lbs of hay/day/animal</p> <p style="text-align: right;">_____ (A) ÷ %DM = _____ (B)</p>
<p><b>Step 3. Calculate feed wastes/day/animal</b></p> <p>Feed requirement (feed)/animal/day X Estimated feed wastes = Feed wastes/day/animal            Example: 41.2 lb of hay/animal/day X 0.20 = 8.2 lb feed wastes/animal/day</p> <p style="text-align: right;">_____ (B) x 0.20 = _____ (C)</p>
<p><b>Step 4. Calculate total feed required/day/animal</b></p> <p>Hay required/day/animal + Added hay to make up for wastage/day/animal = Total hay required/day/animal            Example: 41.2 lb of hay/day/animal + 8.2 lb/day/animal = 49.4 lb of hay/day/animal</p> <p style="text-align: right;">_____ (B) + _____ (C) = _____ (D)</p>
<p><b>Step 5. Calculate total feed required/animal over the wintering season</b></p> <p>Total hay required/day/animal X Number of days on the wintering site = Total hay required/wintering season/animal            Example: 49.4 lb of hay/day/animal X 200 days = 9880 lb of hay/wintering season/animal</p> <p style="text-align: right;">_____ (D) X _____ no. of days = _____ (E)</p>
<p><b>Step 6. Calculate total feed required over the wintering season for the herd</b></p> <p>Total hay required/wintering season/animal X Total number of animals in herd = Total hay required/wintering season/herd            Example: 9880 lb of hay/wintering season/animal X 100 head = 988,000 lb of hay/wintering season/herd</p> <p style="text-align: right;">_____ (E) X _____ no. of head = _____ (F)</p>

**Step 7. Calculate total number of bales of hay required over the wintering season for the herd**

Total hay required/wintering season/herd ÷ weight/hay bale = Total number of bales required

Example: 988,000 lb of hay/wintering season/herd ÷ 1300 lb/bale = 760 bales

$$\text{_____ (F)} \div \text{_____ lb/bale} = \text{_____ (G)}$$

**Step 8. Calculate the bale density based on the bale spacing used over the wintering season**

Area of one acre (43560 square feet per acre) ÷ (Distance between bale centres within row x Distance between bale centres between rows) =

Bales per acre

Example: 43560 square feet / acre ÷ (35 feet X 35 feet) = 35.6 bales per acre

$$\text{_____ square feet / acre} \div (\text{_____ feet} \times \text{_____ feet}) = \text{_____ (H)}$$

**Step 9. Calculate the number of acres used for feeding over the winter season**

Total number of bales (G) ÷ bale density (H) = # of acres

Example: 760 ÷ 35.6 = 21.3 acres

$$\text{_____ (G)} \div \text{_____ (H)} = \text{_____ (I)}$$

**Step 10. Calculate the nitrogen load onto the field over the wintering season**

Depends on the protein content, best determined through a feed analysis – could maybe use an average of 10% for hay.

Nitrogen content normally = protein ÷ 6.25. Protein content (%) ÷ 6.25 X dry matter content of bale X bale weight X # bales (G) = lb Nitrogen (N)

Example: 0.10 ÷ 6.25 X 0.85 X 1300 lb/bale X 760 bales = 13,437 lb N

$$\text{_____ \% protein} \div 6.25 \times \text{_____ \% DM} \times \text{_____ lb/bale} \times \text{_____ bales} = \text{_____ (J)}$$

**Step 11. Calculate the phosphorus load onto the field over the wintering season**

Depends on feed type and quality, best determined through a feed analysis – could maybe use an average of 0.20% for hay.

Phosphorus content (%) X dry matter content of bale X bale weight X # bales (G) = lb Phosphorus (P)

Example: 0.0020 X 0.85 X 1300 lb/bale X 760 bales = 1,680 lb P

$$\text{_____ \% protein} \div 6.25 \times \text{_____ \% DM} \times \text{_____ lb/bale} \times \text{_____ bales} = \text{_____ (K)}$$

**Step 12. Calculate the nitrogen load on a per acre basis in the feeding area over the wintering season**

Nitrogen Load (J) ÷ Number of Acres (I) = Nitrogen Load per Acre

Example: 13, 437 ÷ 21.3 acres = 630 lb N / acre

$$\text{_____ (J)} \div \text{_____ (I)} = \text{_____ (L)}$$

**Step 13. Calculate the phosphorus load on a per acre basis in the feeding area over the wintering season**

Phosphorus Load (K) ÷ Number of Acres (I) = Phosphorus Load per Acre

Example: 1,680 ÷ 21.3 acres = 78.9 lb P / acre

$$\text{_____ (K)} \div \text{_____ (I)} = \text{_____ (M)}$$

Note: Almost all nutrients imported onto the field in the form of feed remain on the field after feeding in the form of manure or waste feed. Only about 1% of the nutrients are removed by cattle weight gain. The per acre nutrient load also assumes that the majority of nutrients remain in the feeding area where cattle spend most of their time.



Table A2. Total Nitrogen Concentration/Acre based on Percentage of Feed Crude Protein Levels and Bale Density

		Bale Spacing Centre to Centre (ft)*								
		20	25	30	35	40	45	50	55	60
		Bale Density (#bales/ acre)	109	70	48	36	27	22	17	14
		Total N lb/ac based on 1500 lb bales and bale density								
Protein (%)	6%	1412.6	907.2	622.1	466.6	349.9	285.1	220.3	181.4	155.5
	8%	1883.5	1209.6	829.4	622.1	466.6	380.2	293.8	241.9	207.4
	10%	2354.4	1512.0	1036.8	777.6	583.2	475.2	367.2	302.4	259.2
	12%	2825.3	1814.4	1244.2	933.1	699.8	570.2	440.6	362.9	311.0
	14%	3296.2	2116.8	1451.5	1088.6	816.5	665.3	514.1	423.4	362.9
	16%	3767.0	2419.2	1658.9	1244.2	933.1	760.3	587.5	483.8	414.7
	18%	4237.9	2721.6	1866.2	1399.7	1049.8	855.4	661.0	544.3	466.6
	20%	4708.8	3024.0	2073.6	1555.2	1166.4	950.4	734.4	604.8	518.4
	22%	5179.7	3326.4	2281.0	1710.7	1283.0	1045.4	807.8	665.3	570.2
	24%	5650.6	3628.8	2488.3	1866.2	1399.7	1140.5	881.3	725.8	622.1
	26%	6121.4	3931.2	2695.7	2021.8	1516.3	1235.5	954.7	786.2	673.9

\* For example, a bale spacing of 20 ft means that there are 20 ft between bales in a row and 20 ft between rows

Table A3. Total Phosphorus Concentrations/Acre based on Percentage Feed Phosphorus Content Levels and Bale Density

		Bale Spacing Centre to Centre (ft)*								
		20	25	30	35	40	45	50	55	60
		Bale Density (#bales/ acre)	109	70	48	36	27	22	17	14
		Total P lb/ac based on 1500 lb bales and bale density								
Total Phosphorus Content (%)	0.08	111.2	71.4	49.0	36.7	27.5	22.4	17.3	14.3	12.2
	0.10	139.0	89.3	61.2	45.9	34.4	28.1	21.7	17.9	15.3
	0.12	166.8	107.1	73.4	55.1	41.3	33.7	26.0	21.4	18.4
	0.14	194.6	125.0	85.7	64.3	48.2	39.3	30.3	25.0	21.4
	0.16	222.4	142.8	97.9	73.4	55.1	44.9	34.7	28.6	24.5
	0.18	250.2	160.7	110.2	82.6	62.0	50.5	39.0	32.1	27.5
	0.20	278.0	178.5	122.4	91.8	68.9	56.1	43.4	35.7	30.6
	0.22	305.7	196.4	134.6	101.0	75.7	61.7	47.7	39.3	33.7
	0.24	333.5	214.2	146.9	110.2	82.6	67.3	52.0	42.8	36.7
	0.26	361.3	232.1	159.1	119.3	89.5	72.9	56.4	46.4	39.8
	0.28	389.1	249.9	171.4	128.5	96.4	78.5	60.7	50.0	42.8
	0.30	416.9	267.8	183.6	137.7	103.3	84.2	65.0	53.6	45.9

\* For example, a bale spacing of 20 ft means that there are 20 ft between bales in a row and 20 ft between rows





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A Guide to Selecting and Managing a  
Wintering Site in Western Canada

