NORTH DAKOTA
ENGINEERING PRACTICE PLANNING GUIDE
Livestock Shelter Structure

PRACTICE STANDARDS: 576 (Livestock Shelter Structure)

REFERENCES

In addition to Section IV of the Field Office Technical Guide, the following are recommended technical references for planning Livestock Shelter Structures:

- Midwest Plan Service (1987) Beef housing and Equipment Handbook.

The following papers were used in the development of this planning guide:

- Anderson, V., et al. (2011) Winter Management of the Beef Cow Herd. NDSU Extension Service Publication AS1564.
- Bates, E., & Phillips, R. (1980). Effect of a Solid Windbreak in a Cattle-Feeding Area. Agricultural Experiment Station, Station Bulletin 646.
- Brandle, J., Hodges, L., Zhou, X. (2004). Windbreaks in North American Agricultural Systems. *Agroforestry Systems*. 61: 65-78.
- Church, J. (2012, March 1). Windbreaks for Cattle. Over the Wire.
- Jairell, R. and Schmidt, R. (1991, December 3-5). Taming Blizzards for Animal Protection, Drift Control, and Stock Water. Proceedings from The Range Beef Cow Symposium XII. Fort Collins, Colorado.
- Jairell, R. and Schmidt, R. (1988, April 18-21). Portable Animal Protection Shelter and Wind Screen. Proceedings from the Western Snow Conference. Kalispell, Montana.
- Jairell, R. and Tabler, R. (1985, April 16-18). Model Studies of Snowdrifts Formed by Livestock Shelters and Pond Embankments. Proceedings from the Western Snow Conference. Boulder, Colorado.
- Jones, D., Friday, W., and DeForest, S. (1983). Wind and Snow Control Around the Farm. Purdue University-Cooperative Extension Service. NCR-191.
- Portable Windbreak Fence. (2002). In Agri-Facts (Agdex 711-1). Alberta Agriculture, Food, and Rural Development.
- Smith, A. (2011). Nutrient Export in Run-Off from an In-Field Cattle Overwintering Site in East-Central Saskatchewan. Thesis. University of Saskatchewan, Department of Soil Science.
- Snow and Wind Control for Farmstead and Feedlot. (1978). Agriculture Canada. Publication 1461.
- Wind and Snow Fences (1997). Agdex 724. British Columbia Ministry of Agriculture, Food, and Fisheries.

OVERVIEW

Winters in North Dakota can be cold, windy, and snowy which can be hard on livestock. Often producers allow cattle access to riparian areas due to their natural protection, but at the cost of water quality. Livestock shelters can provide comfort by reducing cold stress while protecting sensitive areas such as riparian and native rangeland. Livestock shelters also allow for manure management by feeding on areas that lack soil fertility and by moving the feeding location daily around the shelter. There are several forms of windbreaks including natural (tree/shrubs), stacked haybales, snow fences, or manmade structures as described in this planning document.

Did You Know…

- Typically blowing snow is more problematic than the snowfall itself, with snow drifting starting when winds reach 9 mph (Winds and Snow Fences, 1997).
- Animals naturally produce a constant heat supply which maintains body temperature over a wide range of temperatures (through activity such as heart, lungs, stomach, etc all doing their normal functions). The temperature range in which this occurs is called the comfort zone, with the critical temperature being the lowest point in the zone. (Agriculture Canada, 1978)
- Steers on full feed ration have a still-air critical temperature of -22 degrees F while cows and calves on a restricted ration may be 0 degrees F. (Agriculture Canada, 1978)
- Cold stress in cattle occurs when wind combines with cold temperatures. University of Idaho reports 20 mph of wind = 30 degrees of cold. When cattle get cold stress they need more energy (food) to stay warm. The laws of physics tells us what goes in, must come out. Therefore, from a manure management standpoint using less energy is better.
- General principles of fluid dynamics influence the design *(from Jones, Friday, and DeForest, 1983):*
  - *When high velocity air blows over a rough surface, it swirls and loses both energy and velocity*
  - *When high velocity air strikes an obstacle, the air pressure increases on the upwind side, and a slight vacuum is created on the downwind side.*
  - *When high velocity air passes through a constriction, its velocity increases*
  - *High velocity air can hold more snow in suspension than low velocity air.*
- While no fool proof system for wind and snow control exist, the methods described below will help minimize problems associated with wind and snow.

RESOURCE INVENTORY CONSIDERATIONS - Wind Protection

1. Meet with the livestock manager onsite. Determine type of livestock, current and future herd size, and any expected changes of management concerning the livestock.

2. Evaluate the current management system, identify where cattle are currently obtaining wind protection. Spend time onsite looking at the conditions, discuss with the livestock manager how livestock have been managed in the past and what the goals are for the future. Discuss how and where cattle are fed throughout the year. Discuss existing watering facilities/access for the cattle.

3. Evaluate if a livestock shelter structure will protect sensitive areas (wooded areas, stream banks, wetlands, rangeland, and concentrations of Big Sagebrush). If so discuss with the livestock manager the use of livestock exclusion (via fence) for those areas.

4. Evaluate if a livestock shelter structure will be used to provide wind protection for livestock that winter on cropland/hayland/tame pastureland.
   a. If feeding is planned on cropland consider the impact feeding may have on weed control (Cool Season grasses, annual weeds)
   b. *Note the requirement to facilitate the distribution of manure. A nutrient management plan (NRCS CPS Nutrient Management Code 590) shall be developed when livestock are winter feeding mechanically harvested feeds on cropland, hayland, or tame pastureland. Shelter and feeding locations shall not be located in areas identified as having a high Phosphorous Index in the Nutrient Management Plan.* Ensure the producer is willing to meet the requirements in the standard.

5. Determine the prevailing wind direction, does it change during critical time periods such as during calving season?

6. Complete an onsite site investigation to determine potential livestock shelter structure locations, and identify those on a map. Identify riparian areas, wetlands, surface water bodies, wells, and concentrated water flow paths on a topo map (don't forget melting snow follows the same path as water!). Identify existing fencelines and other obstacles that may be in the potential snowdrift zone on the map, current watering facilities, and sensitive areas on the map. For portable structures discuss potential for movement to varying locations to meet needs, feasibility, and management.

7. Evaluate the potential for vegetation reestablishment at the site (more critical for permanent livestock shelters that are built onsite). Is there adequate topsoil and moisture available to reestablish sod or will Heavy Use Area Protection be needed?

DEVELOPING AND EVALUATING ALTERNATIVES

1. Determine the shape of the shelter (90^{o} "V" shaped, semi-circular shaped, or straight line)

    a. *90^{o} "V" shaped and Semi-Circular*
    These shapes are typically used for variable wind direction, as the largest area of protection downwind occurs when wind flows perpendicular to the barrier (Bates and Phillips, 1980). While porous material has been found to give better wind protection, it is not recommended for blizzards, blowing snow, or when snow accumulation is undesirable (Jairell and Schmidt, 1988). Therefore the following information is provided for solid structures.

    Research has shown wind and snow protection is very similar for the two shapes. Jairell and Tabler found snow drifts to extend downwind ~5 times the shelter width/diameter (D) with a minimum open space between the snowdrift wings to be 0.75D for the "V" shape and 0.5D for the semicircle (Figure 1). The minimum open space is typically found ~1.5D downwind of the end of the shelter walls. It is important to understand where snowdrifts will occur to ensure cattle can access the shelter area throughout the winter without obstacles, such as fences, blocking their path. It is also important to plan for drainage from the snowdrift, ensuring melting snow does not drain towards the structure or cause pollution problems.

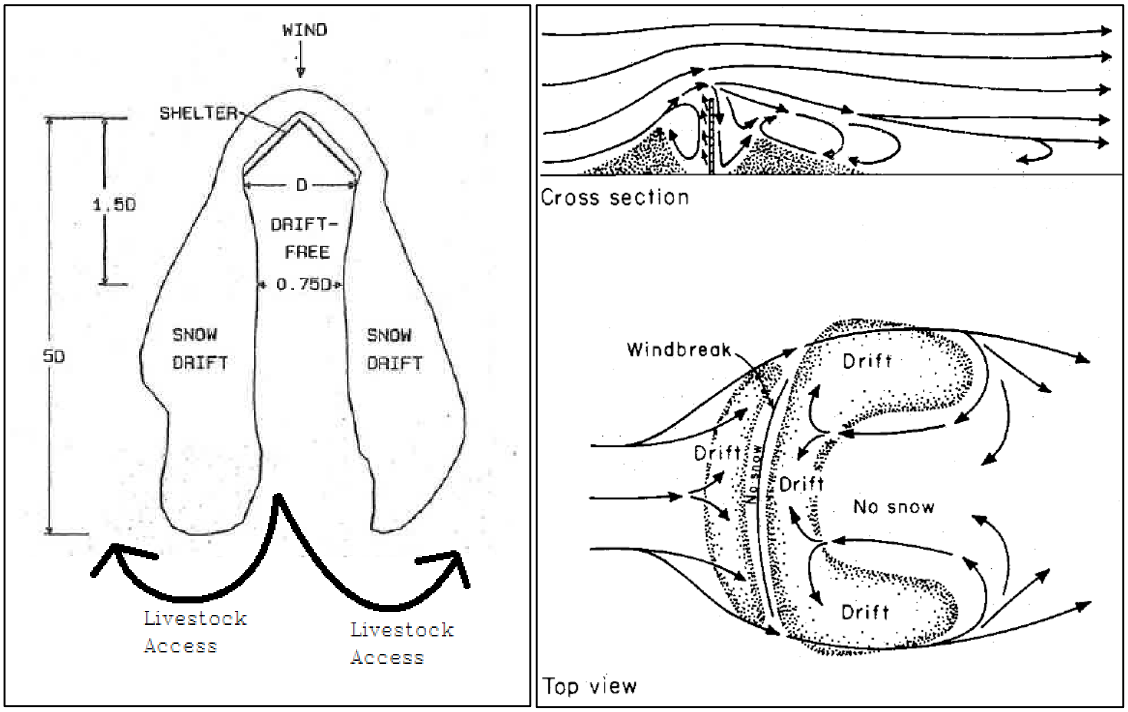

Figure 1a (left) Snowdrift from a solid "V" shaped shelter (Jairell and Schmidt, 1988). Figure 1b (right) shows wind patterns and snow drift patterns for a solid semi-circular shaped shelter (Bates and Phillips, 1980).

Jairell and Tabler recommend tall structures to be used to avoid snowdrifting problems, with the width/diameter not exceeding 15 times the height.

If snowfences are used upwind of the livestock shelter or used to protect the open side of the shelter they should not be placed closer than 30h + 10H (where h= height of snowfence and H= height of livestock shelter).

Research in eastern Oregon found livestock spent as much time on the upwind side of solid semi-curved structures as they did on the downwind side of the structure. They also found a narrow band of wind reduction on the windward side of the structure (Bates and Philips, 1980).

Semi-circular shaped shelters can be built with approximately the same quantity of materials as the "V" design. The ratio of protected area to shelter length is about 27 percent higher than in the "V" shape. Semi-circular shelters are generally the most economical (material cost per square foot); however, the type of material used for board or panels can be a limiting factor due to the shape. (Jairell and Tabler, 1985).

b. *Straight Line*

Typical use for straight line fabricated structures in North Dakota is windbreak protection for open feedlots. Structures may be designed either as solid barriers or as porous structures. In general, structure orientation should be approximately perpendicular to winter and early spring prevailing wind direction.

Care should be taken when placing shelters near open sided buildings, as the swirling action of wind can result in snow drifts inside the building. Figure 2 illustrates the problem of snow drifting around an open sided building (either with or without a livestock shelter structure (labeled fence)). The livestock shelter should be placed outside the swirl chamber, which is typically as wide as the building is deep. (Agriculture Canada, 1978).

The location of other buildings can cause wind and snow to be deflected. Other structures such as buildings, silos, feed stacks, etc should be located 33 – 66 feet away from any open sided buildings to prevent undesirable snow drifts (see Figure 2). Stacks of feed or bedding can be stacked in a planned location to provide added protection.

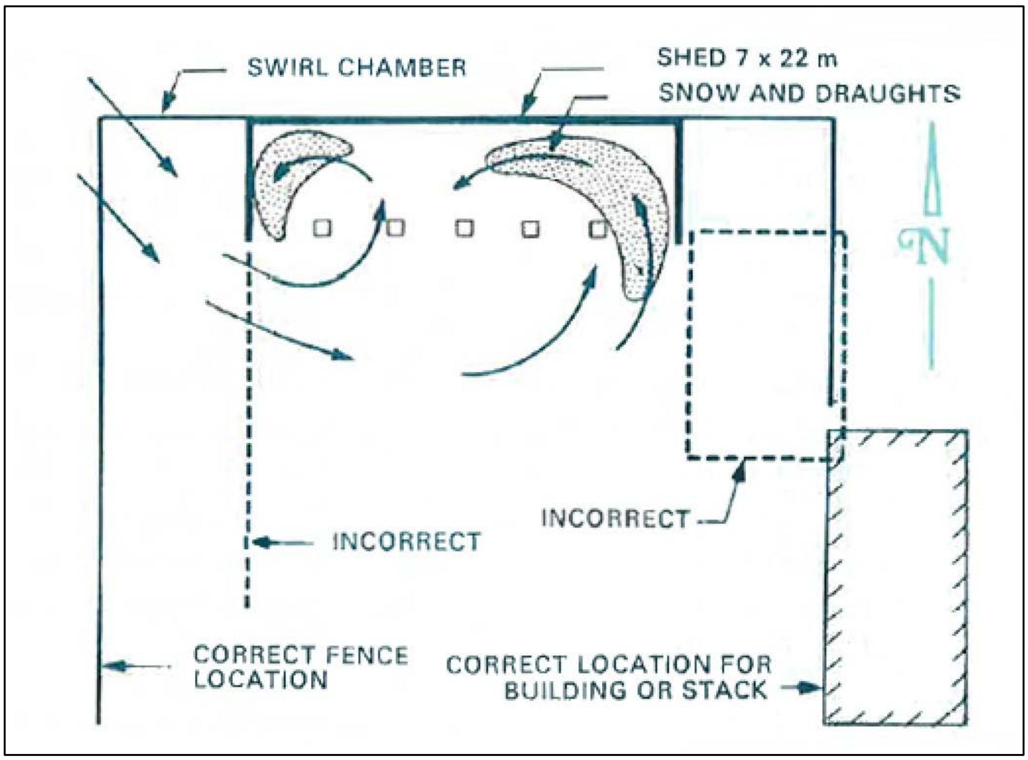

Figure 2. Schematic of snow drifting into an open sided building (Agriculture Canada, 1978).

If wind blows directly at the front of an open sided building a solid structure can be placed ~200’ from the building to block wind and snow. To provide further protection consider adding temporary curtains to the building. In addition, buildings that experience winds from a 45 degree angle should have partitions every 33 feet to reduce wind (Agriculture Canada, 1978).

Solid structures force air to go over or around the structure, which results in an increase in air pressure on the windward side and a slight vacuum on the leeward side. As the air goes over the structure the velocity increases. After passing over the structure the vacuum on the leeward side causing air turbulence which reduces the energy in the air forcing snow to drop out of the air. Research shows different snow drop distances (Figure 3 and 4).

Research in open areas (away from farmsteads and feedlots) shows solid structures create a characteristic drift to form upwind of the shelter (labeled fence in Figure 3), but results in high turbulence downwind. While a solid structure is very effective at keeping snow out of the leeward side, it is only ~half as effective as a porous structure at reducing the wind.

Drifts formed leeward of a porous structure are dependent on the porosity of the structure (see Figure 3). Structures with 20% porosity will create short deep drifts typically 33 feet wide and slightly deeper than the structure. If there is room for snowdrifts these structures are a great choice because of the wind reduction. However, if there is not adequate drift space, or if the resulting snowmelt will result in drainage or contaminated runoff issues, this structure should not be used.

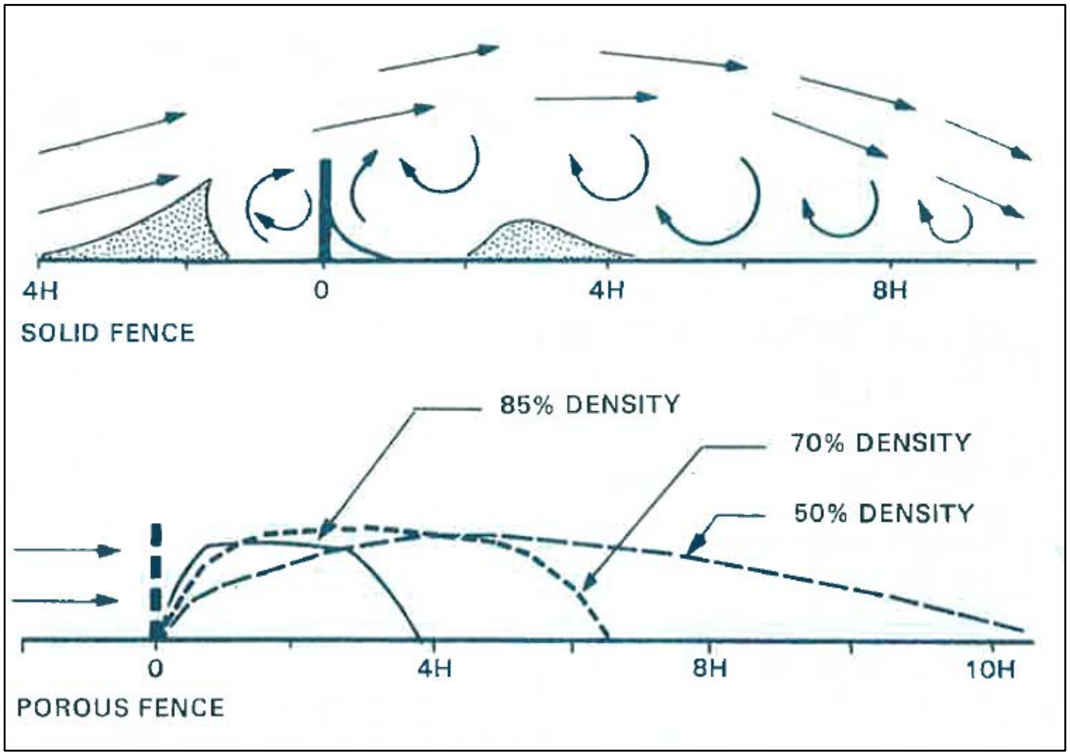

Figure 3. Snow drift windward and leeward of a solid and porous structure. H=height of structure (Agriculture Canada, 1978).

For solid shelters the wind protection area extends 15H downwind of the structure. For porous shelters, the wind protection area extends 20H downwind of the structure. See Figure 4.

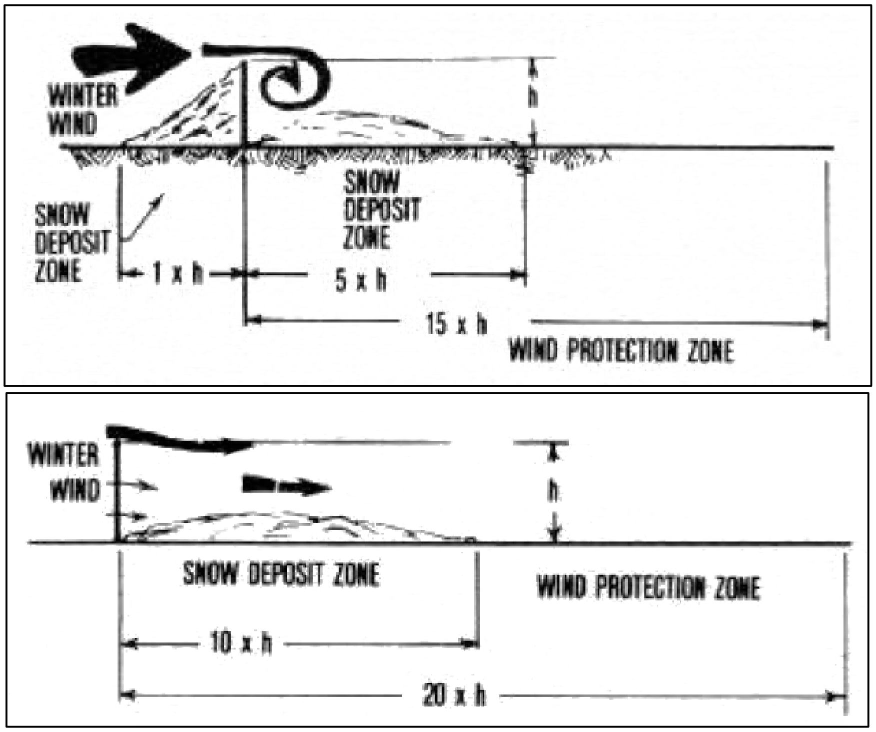

Figure 4a. Wind protection Zone for a Solid Structure (top) and Figure 4b. Porous Windbreak Structure (bottom) (Jones, Friday, and DeForest, 1983)

Porous structures may have openings that run vertically or horizontally. Porous barriers should be mounted approximately 12 inches above the ground to reduce eddy currents (whirlwinds) and allow wind to keep sweeping the snow downwind of the structure.

Figure 5. Slanted walls have been used to allow young animals access to the area under the shelter (Agri-Facts, 2002).

2. Determine the minimum shelter zone area required for the current and future herd size. “V” and semi-circular shelters shall use Table 1. Straight line structures use the rule of thumb of 1 lineal foot of structure per animal.

Table 1. Minimum Shelter Area

Animal Type	**Min. Shelter Area (sq ft/head)**
Dairy, Beef, Horse	35-50*
Swine, Sheep, Goat	10-15
Poultry	3-7

*recommended area for beef is 35 sq ft /head for yearlings and 50 sq ft/head for cows

3. Locate potential structure locations on a plan map, ensuring they meet the minimum requirements of the Livestock Shelter Structure Standard (i.e. meet minimum setback distances from water, allow drainage away from structure, no obstacles blocking livestock movement during winter, etc).

4. Develop livestock access to water alternatives, develop feed management alternatives, and develop sensitive area protection plans (if applicable). Determine potential limitations to the plans and be prepared to discuss with the livestock manager.

5. Develop a managed grazing plan or modify existing plan if applicable.

6. Develop a nutrient management plan or modify existing plan if applicable.

7. Prior to sharing engineering alternatives with the producer, determine the engineering job approval authority for the practices involved. If you do not have adequate Planning (I&E) JAA for the practices, have your work reviewed by another individual in the NRCS who does to make sure you have correctly evaluated all of the options and determined feasible and implementable alternatives. At the point those are presented to a producer, the planner is making a commitment on behalf of the agency that we have provided technically sound, implementable engineering plans.

<u>ASSISTING THE PRODUCER TO MAKE AN INFORMED DECISION</u>

1. Put together some example detail drawings, photos, and/or portions of construction specifications that would be similar to the proposed project. Explaining to a producer exactly what following NRCS standards means in relation to construction of a particular project is very important. Producers often understand the final concept better with drawings and written documents than a verbal explanation.

2. Estimate actual construction costs for the project based on similar completed projects (consult with other individuals as necessary). Calculate expected financial assistance if planning is being done in conjunction with a program application.

3. Meet with the producer and review the feasible alternatives discussing factors that will be important to them in their decision: installation requirements, initial investment, impacts on farming operations, lifespan, and maintenance needs. Encourage them to talk with potential

contractors/manufactures at this point and offer your assistance to estimate their potential out of pocket costs more accurately.

4. IMPORTANT NOTE for PORTABLE WINDBREAKS: explain to the producer that North Dakota NRCS no longer “pre-approves” panels from manufacturers. It is in the best interest of the producer to work with the contractor/manufacture and NRCS before purchasing a portable panel if the producer is unsure it meet the North Dakota 576 standard and construction specification.

5. In the case of a program application, it is important that producers understand exactly how implementation would proceed and what restrictions they will operate under. Ensure that they understand that used materials are not acceptable (with the exception of drill stem – see the ND 576 Specification for details), no construction may proceed until they have received final design drawings and specifications, and that NRCS will inspect prior to accepting the as-built documentation.

6. Provide adequate time for the producer to make an informed decision. If they don’t have time to meet to discuss alternatives. If they haven’t had time to adequately complete the decision making process, the resulting commitment to implement the plan may be affected. Offer and be willing to defer a program application to allow time for quality planning and good decision making on the part of the producer.

Provide documentation of above steps in the conservation plan narrative, assistance notes, and/or in separate documentation in Part 5 of the plan folder. Job class for each practice involved, and the approving individual for planning work, needs to be included.