Québec 2010
AIPCR · PIARC

XIII INTERNATIONAL WINTER ROAD CONGRESS

QUÉBEC, FEBRUARY 8 TO 11, 2010

WORLD ROAD ASSOCIATION MONDIALE DE LA ROUTE
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SUSTAINABLE WINTER SERVICE FOR ROAD USERS

Implementing Passive Snow and Ice Control Measures

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AASHTO
The Voice of Transportation

IMPLEMENTING PASSIVE SNOW & ICE CONTROL MEASURES

- Winter Weather Can Bring Transportation to a Standstill!!
  - Ice
  - Heavy Snowfall
  - Blowing Snow
- Impacts Safety
- Loss of Mobility
- Huge Economical Impacts

IMPLEMENTING PASSIVE SNOW AND ICE CONTROL MEASURES

- Emphasis on Pro-Active S/I Control Operations
  - Pretreatment
  - More effective chemistry
  - Precise treatment timing
  - Improved equipment

- **RESULTS HAVE BEEN PHENOMENAL!!**

IMPLEMENTING PASSIVE SNOW AND ICE CONTROL MEASURES

- Need more emphasis on implementing passive blowing snow mitigation measures (purpose of this paper)
  - Underutilized resource
  - Environmentally friendly
    - Water conservation
    - Doesn't add chemicals to environment
  - Living snow fence
    - Aesthetically pleasing
    - Wildlife nesting/shelter
  - Cost effective

IMPLEMENTING PASSIVE SNOW AND ICE CONTROL MEASURES

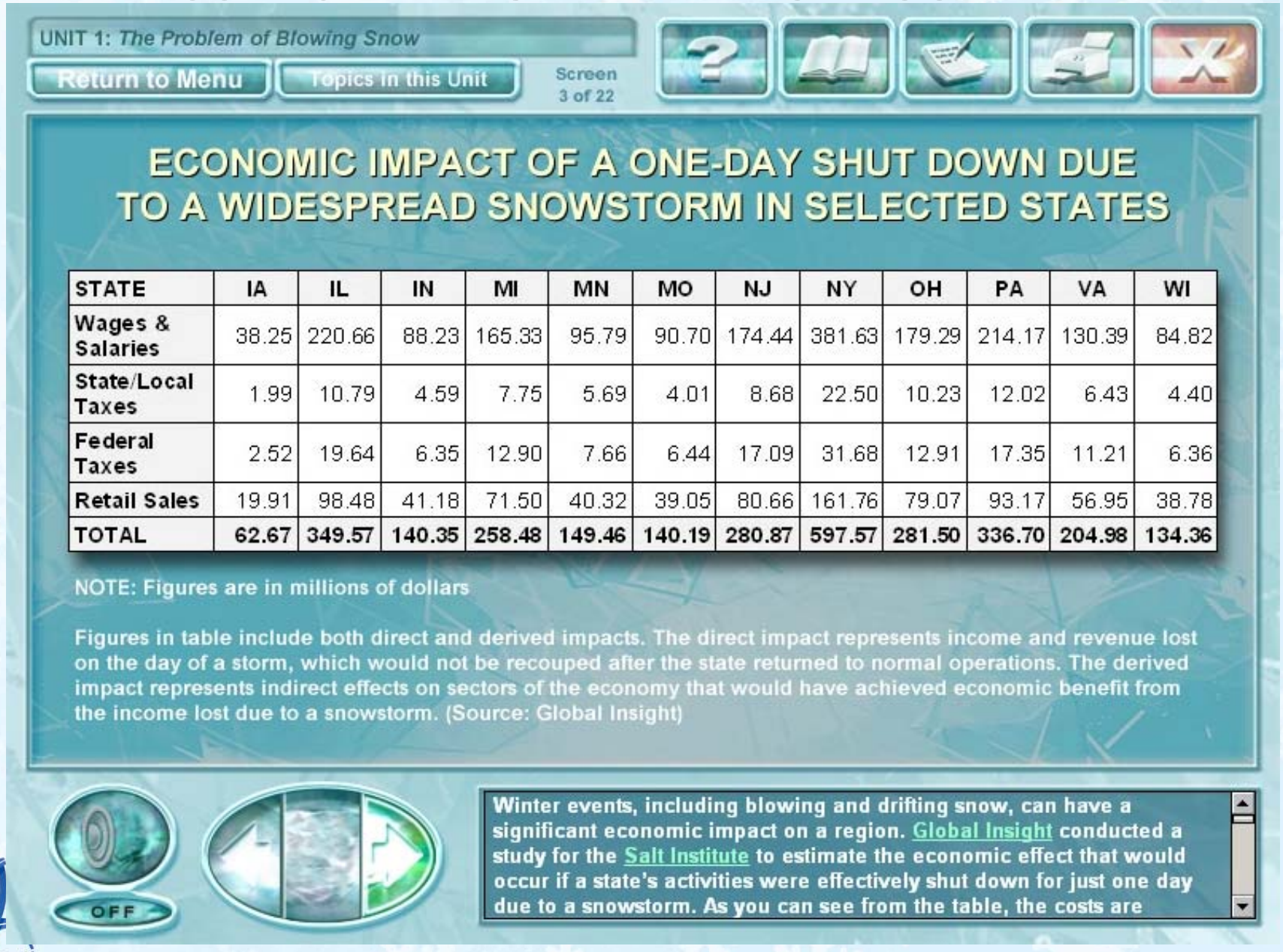
- Passive snow control is not a new technology
  - Early settlers planted wind breaks
  - Railroad builders recognized the problem
- Passive snow control knowledge is improving
  - +Ron Tablers SHRP research (1994)
  - +New snow fence design and fabrics (2003)
  - +Increased knowledge about interaction between atmosphere, terrain, roadway design and blowing snow
  - +Computer assisted snow control technology (avoid constructing problems)

IMPLEMENTING PASSIVE SNOW AND ICE CONTROL MEASURES

- Technology Transfer Efforts
  - +Results from International Winter Maintenance Technology Scanning Tours
  - +On-site training for transportation agencies
  - +On-site problem corrections
  - +Computer-based training program
  - +NYSDOT successfully brought the science of engineered mitigation of blowing snow to a CAD-Microsoft road design application

COMPUTER-BASED TRAINING PROGRAM

COMPUTER-BASED TRAINING PROGRAM



STATE	IA	IL	IN	MI	MN	MO	NJ	NY	OH	PA	VA	WI
Wages & Salaries	38.25	220.66	88.23	165.33	95.79	90.70	174.44	381.63	179.29	214.17	130.39	84.82
State/Local Taxes	1.99	10.79	4.59	7.75	5.69	4.01	8.68	22.50	10.23	12.02	6.43	4.40
Federal Taxes	2.52	19.64	6.35	12.90	7.66	6.44	17.09	31.68	12.91	17.35	11.21	6.36
Retail Sales	19.91	98.48	41.18	71.50	40.32	39.05	80.66	161.76	79.07	93.17	56.95	38.78
TOTAL	**62.67**	**349.57**	**140.35**	**258.48**	**149.46**	**140.19**	**280.87**	**597.57**	**281.50**	**336.70**	**204.98**	**134.36**

UNIT 1: *The Problem of Blowing Snow*

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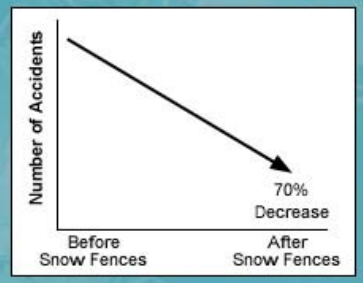
BENEFITS OF SNOW FENCES



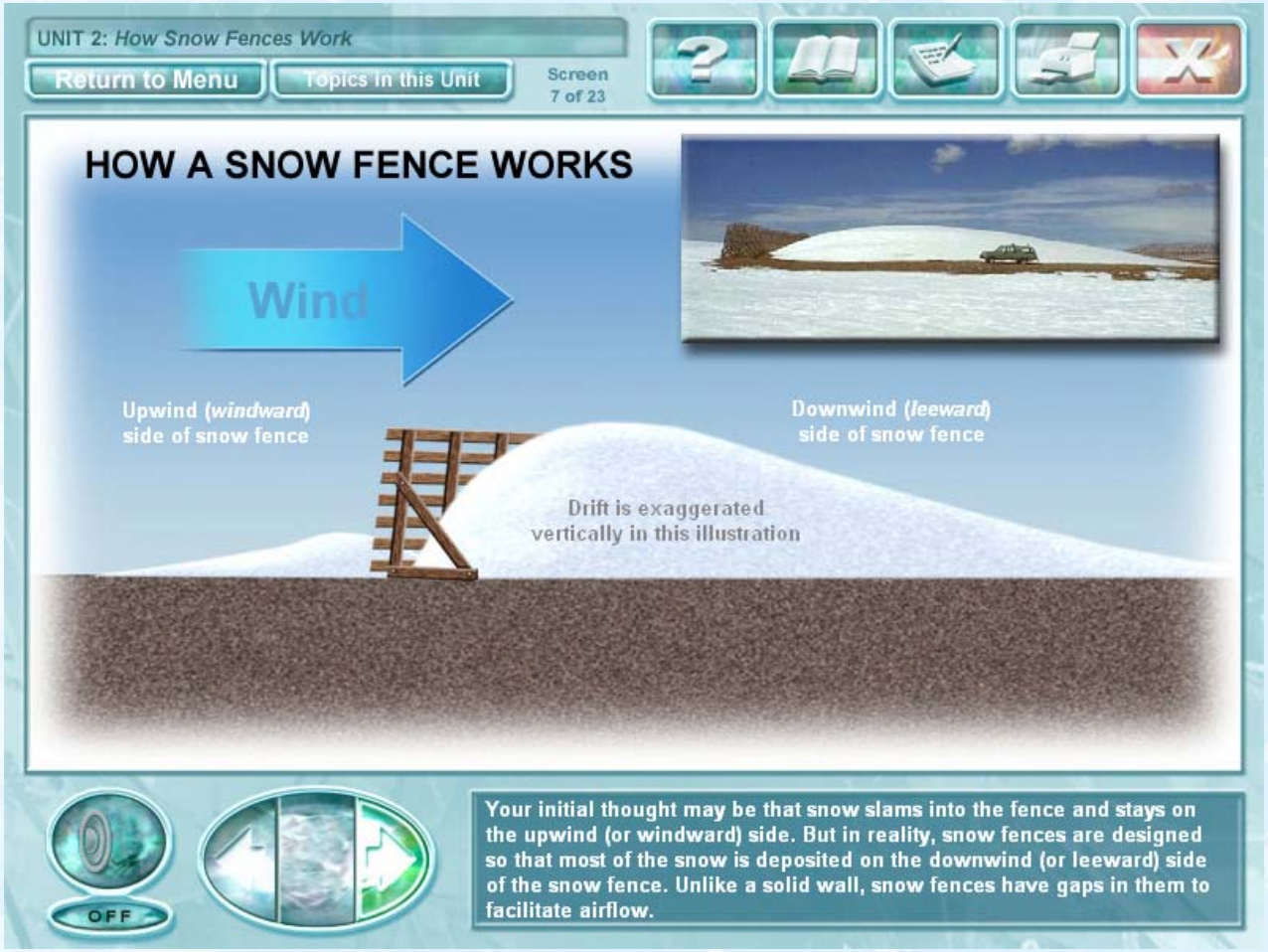
Cost per Ton
Snow Fence vs. Snow Removal

Plowing Costs 100 times the Cost of Snow Fences

OFF

One of the most important solutions to the problem of blowing and drifting snow, as we'll learn later in this course, is the snow fence. For example:

- Along I-80 in Wyoming, the number of accidents caused by poor


UNIT 2: How Snow Fences Work
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HOW A SNOW FENCE WORKS
Wind
Upwind (windward) side of snow fence
Downwind (leeward) side of snow fence
Drift is exaggerated vertically in this illustration
OFF
Your initial thought may be that snow slams into the fence and stays on the upwind (or windward) side. But in reality, snow fences are designed so that most of the snow is deposited on the downwind (or leeward) side of the snow fence. Unlike a solid wall, snow fences have gaps in them to facilitate airflow.


UNIT 4: Structural Snow Fence Design
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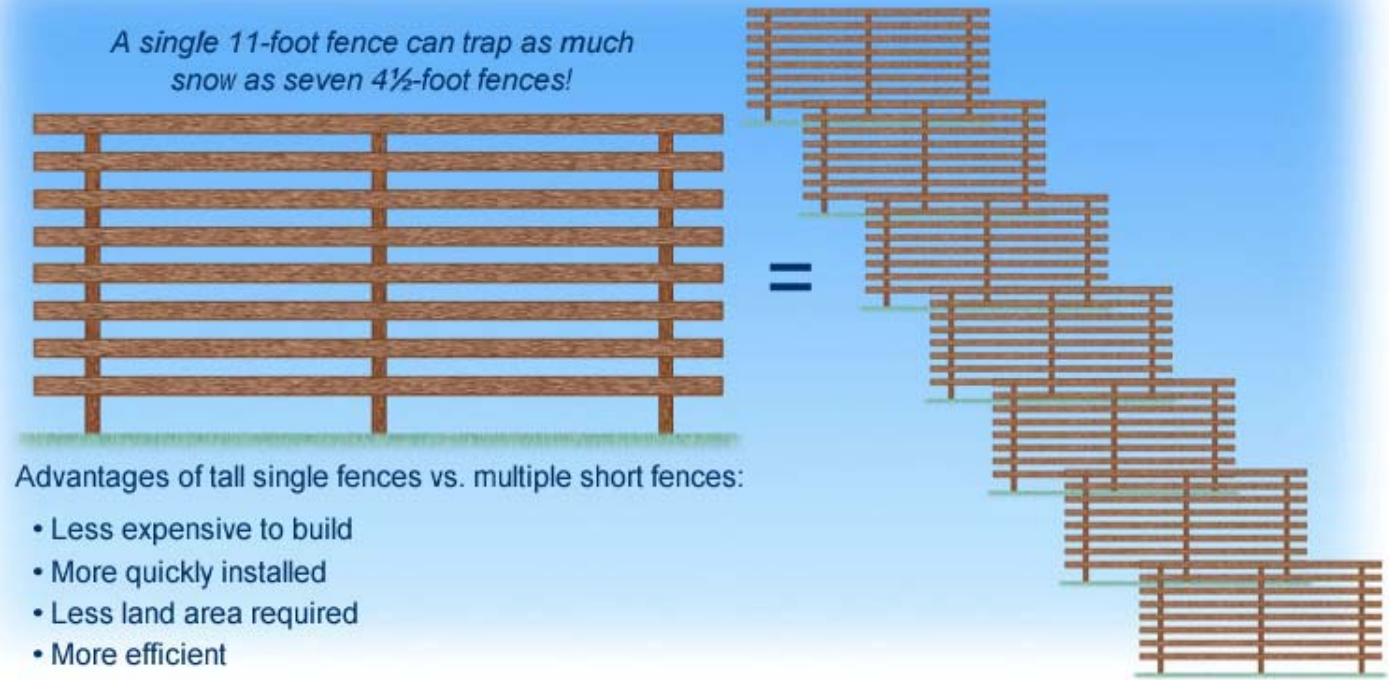
Wind
OFF
Extensive outdoor field research using scale models has been performed to help determine optimal fence design and placement. In this unit you will learn practical techniques and methods for structural snow fence design.

IMPORTANCE OF FENCE HEIGHT

A single 11-foot fence can trap as much snow as seven 4½-foot fences!



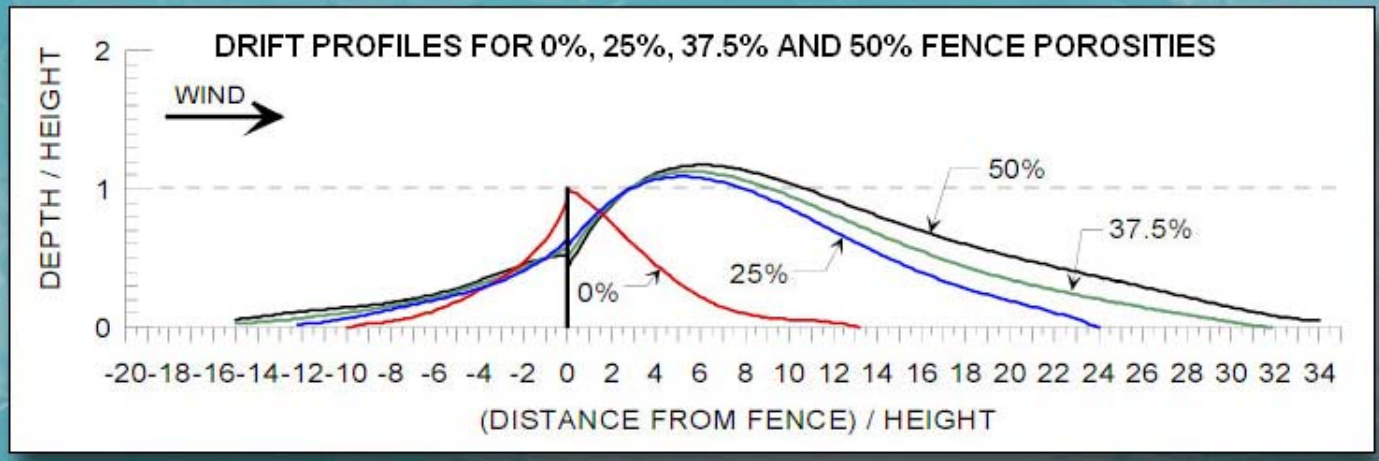
Advantages of tall single fences vs. multiple short fences:

- Less expensive to build
- More quickly installed
- Less land area required
- More efficient

OFF

Fence material, porosity, and size and shape of openings are not nearly as important factors as the fence height. A 6-foot fence will store twice as much snow as a 4-foot fence. In fact, a single 11-foot fence has about the same snow trapping capability as seven 4½-foot fences! There are many advantages to a single tall fence:

FENCE POROSITY



SOURCE: *Controlling Blowing and Drifting Snow with Snow Fences and Road Design*, copyright © Ronald Tabler, 2003

Capacity vs. Porosity Chart

OFF

This chart illustrates the effect fence porosity has on equilibrium drift formation for fences on flat terrain. Assuming unlimited snow transport, solid fences with 0% porosity have the least amount of snow storage capacity with the snow drift extending only 10 times the fence height upwind and 13 times the fence height downwind. Structural snow

UNIT 4: *Structural Snow Fence Design*

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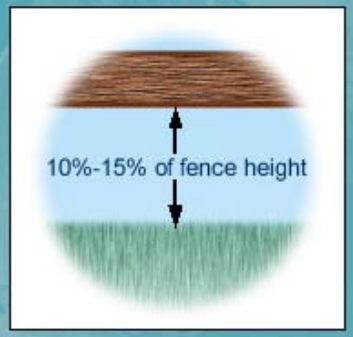
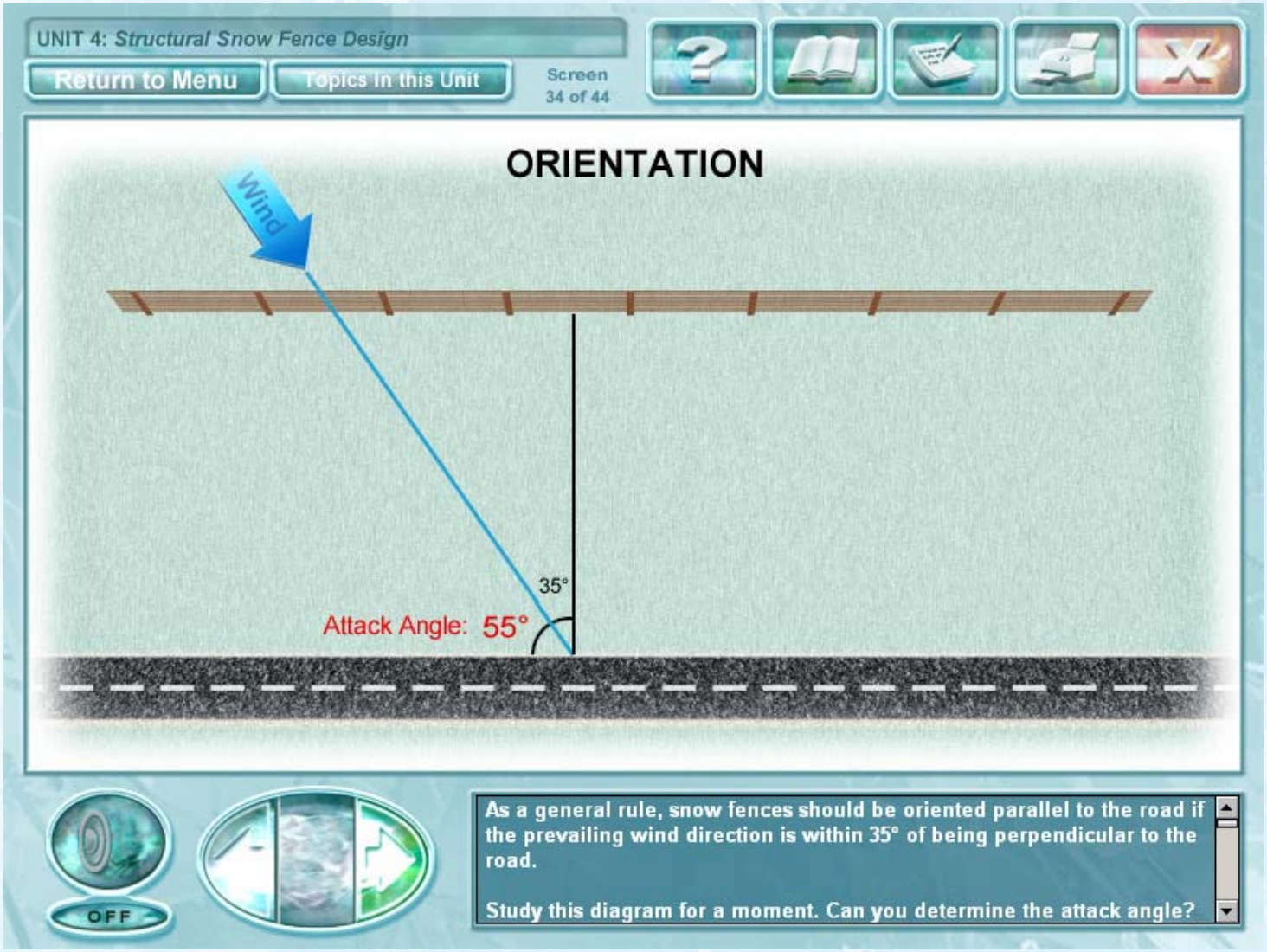
IMPORTANCE OF BOTTOM GAP



OFF

As we mentioned, it's important to leave a space of about 10-15% of the fence height between the ground and the bottom of the fence. If you place a horizontal member of the fence either on the ground or partially in the ground, it will not trap snow efficiently. Here are some additional disadvantages of not maintaining a gap at the bottom of the fence:


UNIT 4: Structural Snow Fence Design
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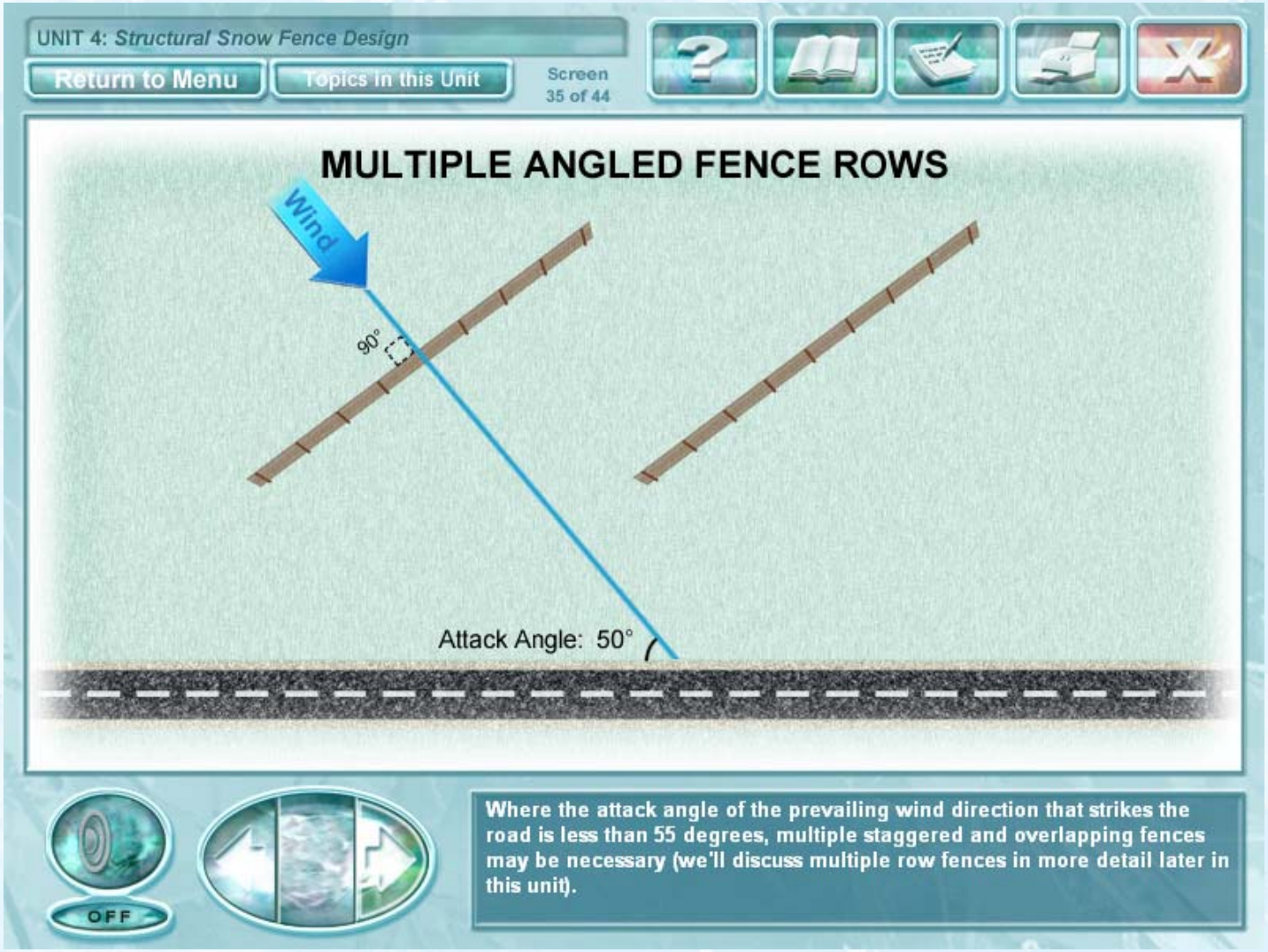
ORIENTATION
Wind
35°
Attack Angle: 55°
OFF
As a general rule, snow fences should be oriented parallel to the road if the prevailing wind direction is within 35° of being perpendicular to the road.
Study this diagram for a moment. Can you determine the attack angle?


UNIT 4: Structural Snow Fence Design
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MULTIPLE ANGLED FENCE ROWS
Wind
90°
Attack Angle: 50°
OFF
Where the attack angle of the prevailing wind direction that strikes the road is less than 55 degrees, multiple staggered and overlapping fences may be necessary (we'll discuss multiple row fences in more detail later in this unit).

UNIT 4: *Structural Snow Fence Design*

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EXTENSION OF FENCE ENDS

OFF

Drifts tend to get rounded near fence ends so be sure your design accounts for the reduction in storage capacity due to this "end effect." This may require the fence be taller and/or extend further.

UNIT 4: *Structural Snow Fence Design*

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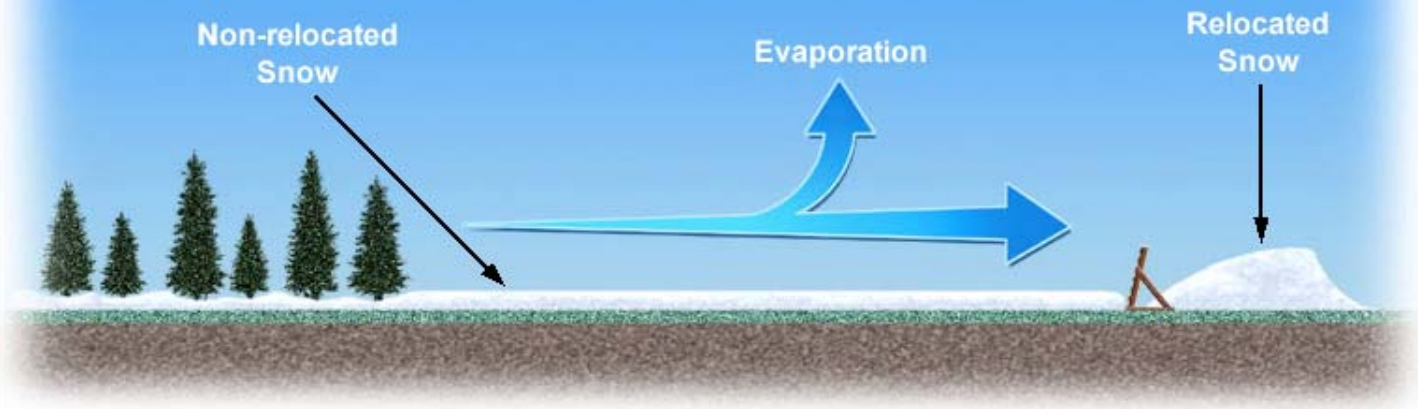
RELOCATED PRECIPITATION



- Value varies by weather conditions, vegetation and topography
- 70% of water-equivalent winter precipitation is a good rule of thumb

OFF

Next, determine the amount of relocated precipitation occurring in the area. This is the proportion of snow that is relocated by the wind during the winter. The value varies with:

- Weather conditions

UNIT 4: *Structural Snow Fence Design*

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USING FETCH CURVES TO DETERMINE SNOW TRANSPORT QUANTITY

EXAMPLE:

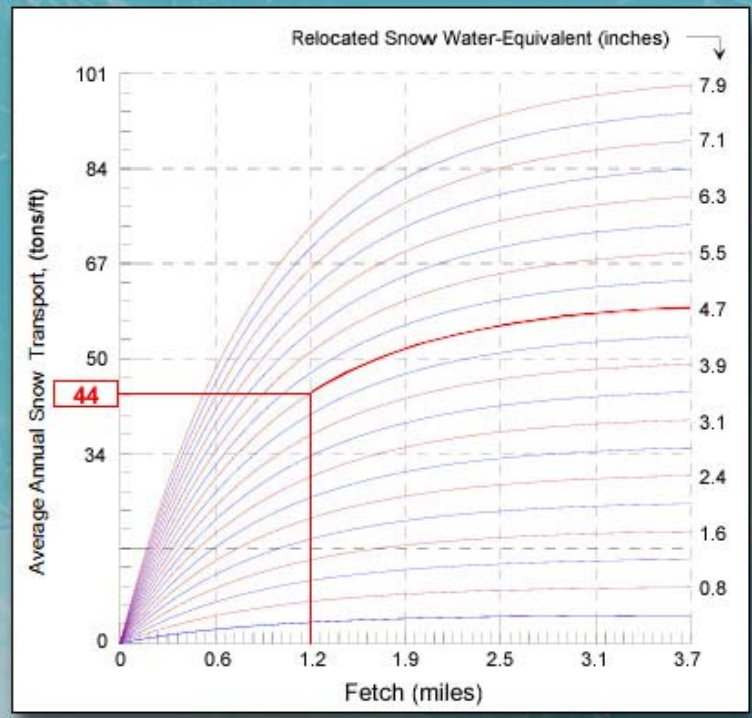
- Fetch = 1.2 miles
- Avg. Annual Snowfall = 67 inches

WATER-EQUIVALENT

67 in. x 10% = 6.7 inches

RELOCATED SNOW:

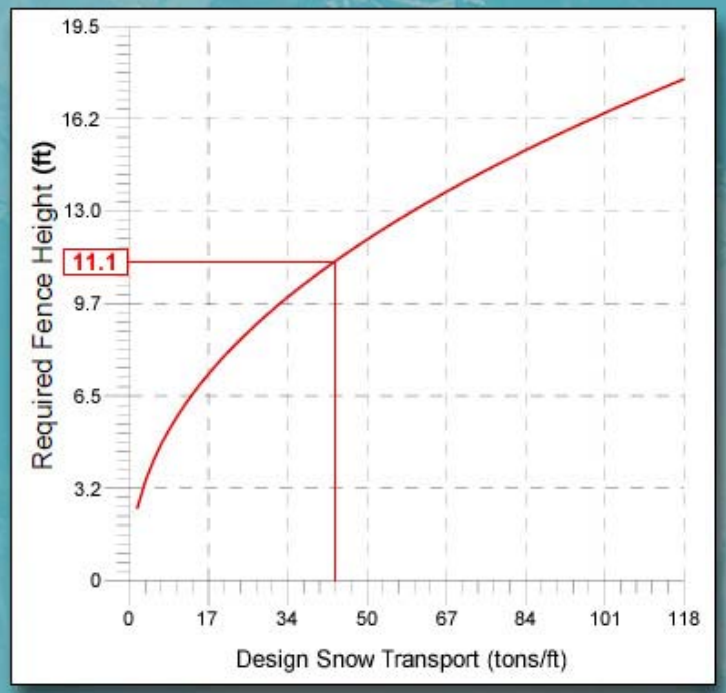
6.7 in. x 70% = 4.7 inches



OFF

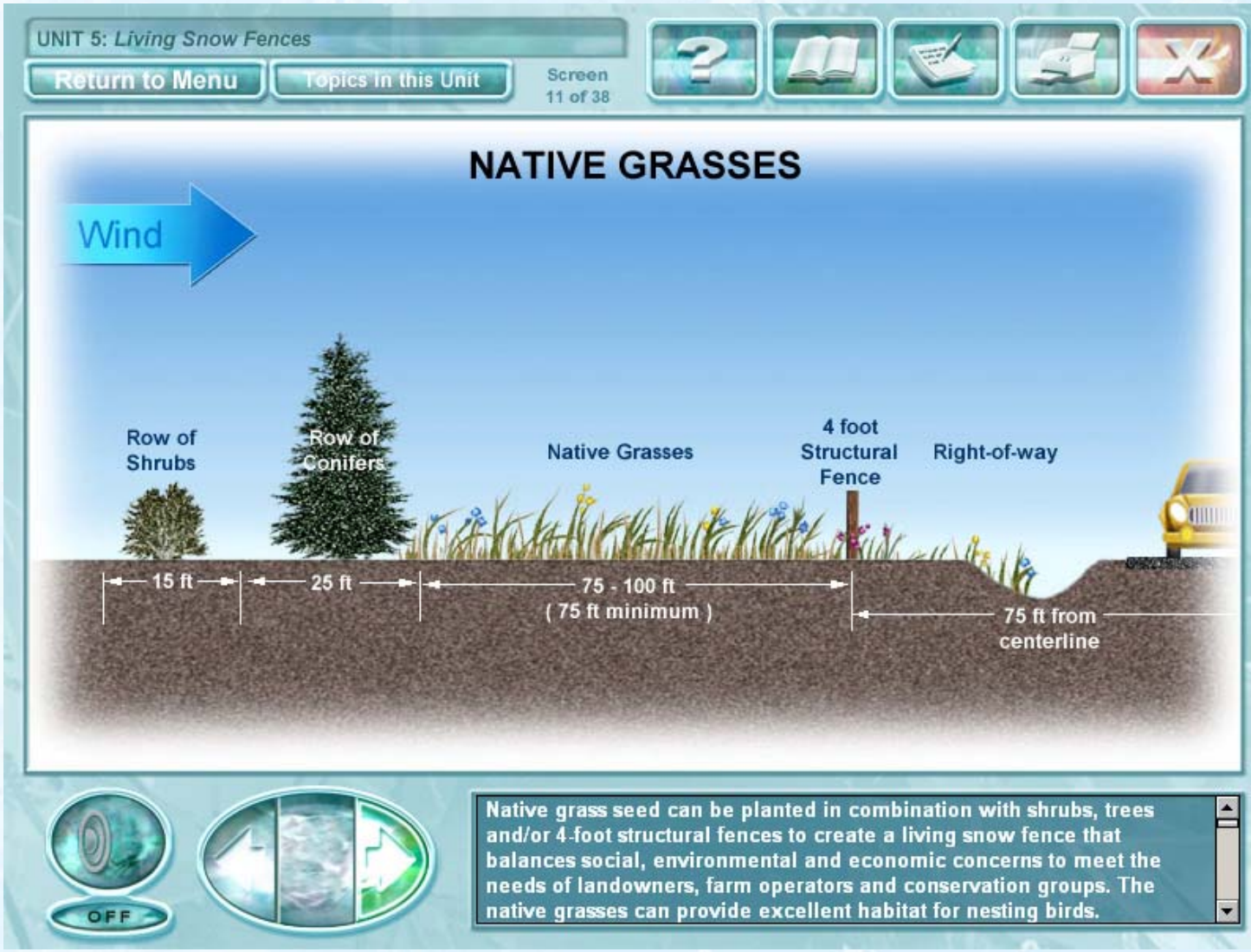
Fetch curves have been developed to help determine the snow transport quantity for your fence design. Let's look at an example. Suppose the fetch upwind of the road is 1.2 miles and the average annual snowfall is 67 inches.

DETERMINE FENCE HEIGHT



OFF

Now that we know how much snow is transported, we can begin determining our fence requirements. Using the curve on this chart, we see that a fence height of about 11 feet is required to accommodate the 44 tons per foot of snow the fence needs to capture, assuming the fence is 50% porous (refer back to example on previous screen).


UNIT 5: Living Snow Fences
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NATIVE GRASSES
Wind
Row of Shrubs
Row of Conifers
Native Grasses
4 foot Structural Fence
Right-of-way
15 ft
25 ft
75 - 100 ft
(75 ft minimum)
75 ft from centerline
OFF
Native grass seed can be planted in combination with shrubs, trees and/or 4-foot structural fences to create a living snow fence that balances social, environmental and economic concerns to meet the needs of landowners, farm operators and conservation groups. The native grasses can provide excellent habitat for nesting birds.


UNIT 5: Living Snow Fences
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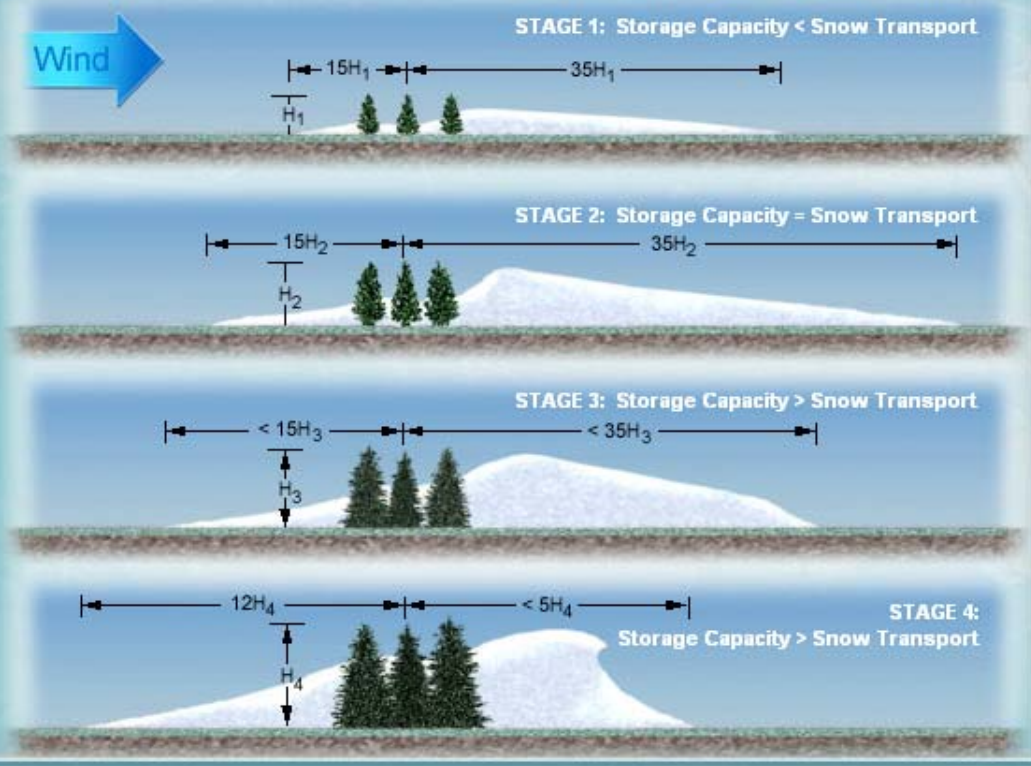
PLANT SELECTOR
Mn/DOT PlantSelector
Plants for Minnesota
A Minnesota Department of Transportation expert system for the selection of landscape plants
Office of Technical Support
About Us
Contact Us
Office of Environmental Services
About Us
Site Map
Other Links
Living Snow Fence
Mn/DOT Home
FAQ
Site Map
Search
Click the link below to open Plant Selector site
http://plantselector.dot.state.mn.us
OFF
The Minnesota Department of Transportation has developed an online plant selector. The plants recommended by the tool are generally appropriate for most central and northern U.S. states, not just Minnesota. You can click the link at the bottom of the screen to open the site now in your Internet browser.

EFFECTS OF PLANT GROWTH



H = Plant Height

OFF

When planting a living snow fence it is important to recognize in advance how the plants' growth over time will impact the fence's snow trapping effectiveness. As the living fence becomes more dense, it acts more like a solid barrier, causing snow to accumulate on the upwind side. At the same time, the downwind drift becomes shorter.

UNIT 5: *Living Snow Fences*

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BEWARE OF GAP DEVELOPMENT

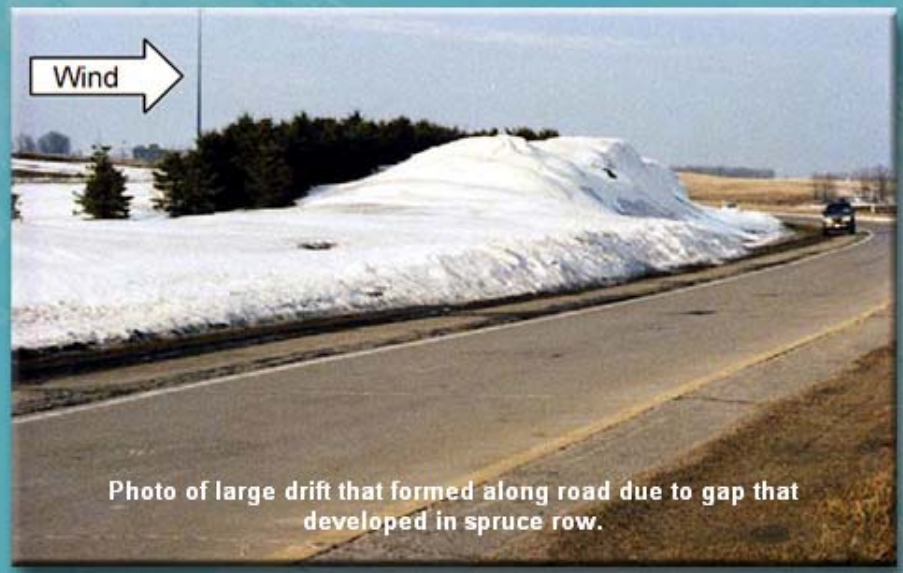

Photo of large drift that formed along road due to gap that developed in spruce row.

OFF

If a gap develops in the fence (such as in the case of a tree in the fence dying), severe drifts can occur. Fill in the gap with a plant the same size as the others in the planted row as soon as possible. Planting two to three staggered rows rather than just a single row can help minimize this problem.

UNIT 5: *Living Snow Fences*

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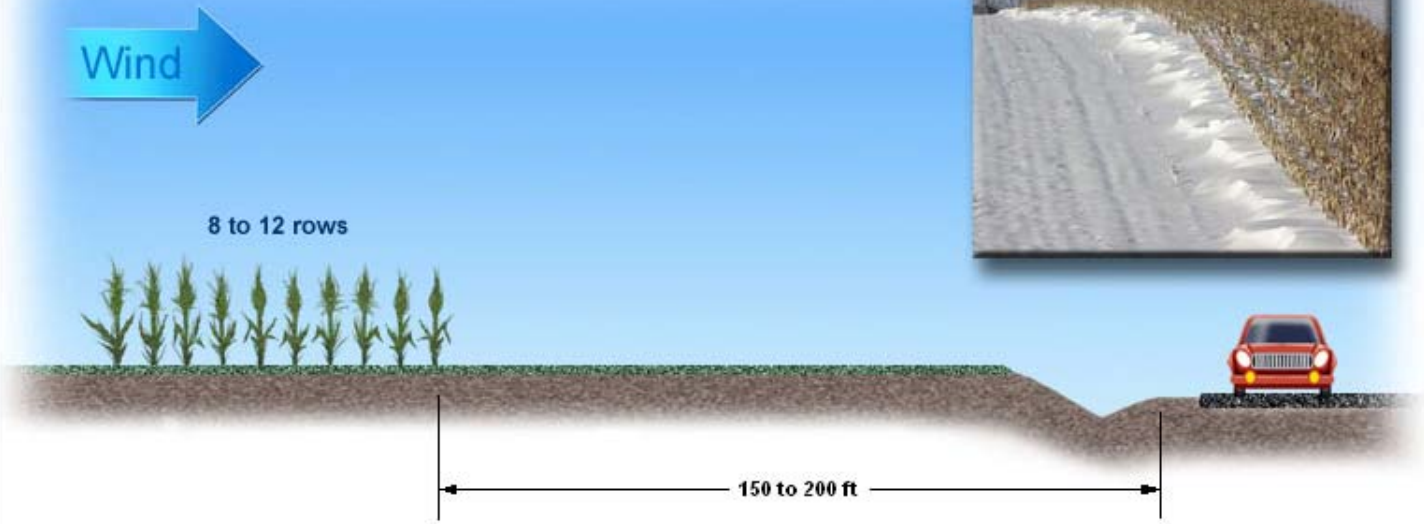
USING CORN ROWS FOR SNOW FENCING



OFF

Corn can serve as an effective yet very economical living fence. In fact, some agencies have found strategic corn rows provide up to 95% savings over a temporary 4-foot snow fence.

An effective snow fence made of corn requires at least 8-12 rows. Set

UNIT 6: *Road Design to Mitigate Blowing Snow*

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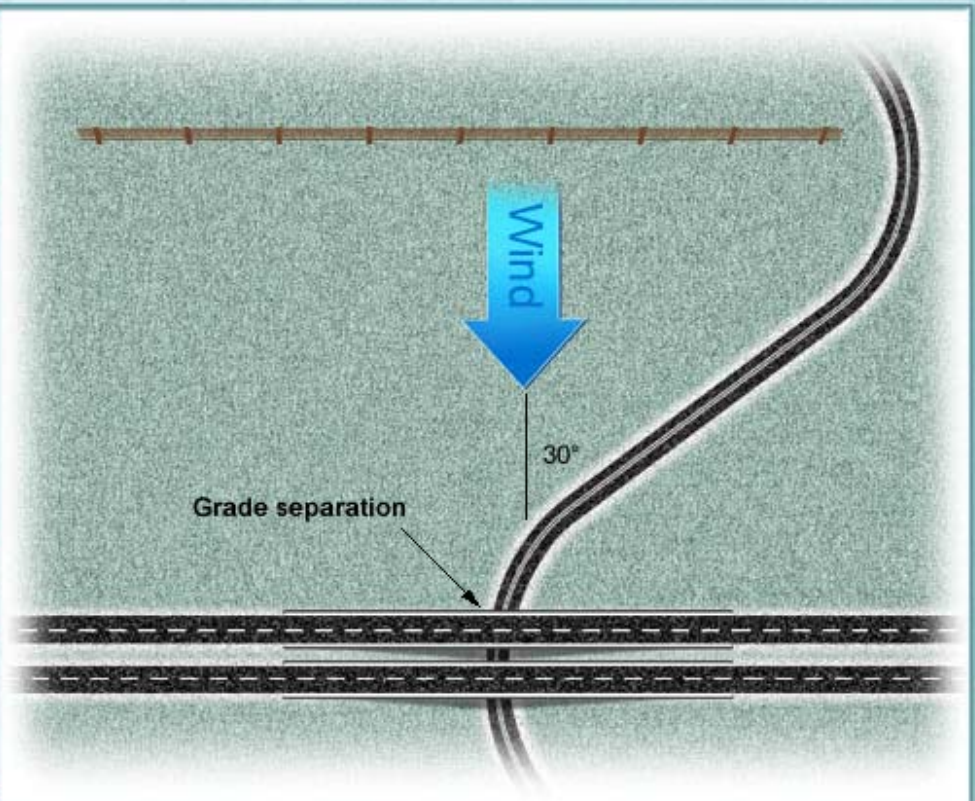
SNOW FENCES IN CONJUNCTION WITH ROAD DESIGN

The photograh above and the illustration on the right both show proper orientation of a snow fence in conjunction with grade separation



OFF

Sometimes the road cannot be designed to fully alleviate blowing snow problems. In these cases, you should include snow fences in the design.

IMPLEMENTING PASSIVE SNOW & ICE CONTROL MEASURES (SUMMARY)

- Passive Measures for Controlling Blowing & Drifting Snow
  - Underutilized resource
  - Being implemented worldwide
  - Environmentally friendly
  - Cost effective
- Engineered Mitigation in Road Design
  - -International winter maintenance technology scanning tours brought new ideas
  - -SNOWMAN software for road design & snow fence design