Task 2-B: Training Workshops for Living Snow Fence Design, Installation and Maintenance

Task 2-B: Training for LSF Design, Installation and Maintenance

Training materials, including a series of seven fact sheets and two PowerPoint presentations, were prepared to assist in design and installation classes. Training materials were created from an extensive literature review of LSF, previous research and development efforts conducted by SUNY- ESF, and improved methods and protocols developed in this project. Five classes were held during the project. The first four classes were held at four different NYSDOT residencies in Onondaga, Erie, Delaware and Oneida Counties. Each class had two sessions.

In the first session, generally held in the fall, participants learned about basics of blowing snow problems, addressing problems with LSF, site assessment and fence design. In the field component of the fall session, students visited a site identified by residency staff as having a blowing snow problem and addressing the factors for site assessment as a group, including talking through potential challenges to fence installation and possible solutions.

The following spring, the class reconvened for a one- or two-day long session. The classroom aspect of the spring session covered LSF design, installation, maintenance and best practices. In the field component of the session, participants observed and assisted in site preparation and installation of a living snow fence on the site. Shrub willow LSF were used in the field sessions, as this vegetation type is recognized as a best practice for LSF due to the rapid growth rate of willow, the ease of propagation from dormant stem cuttings, tolerance of high planting density, consistent porosity, etc. Protocols to assess and measure LSF sites were developed and applied at each site and these methods and findings were presented and applied in each of the classes as part of the comprehensive demonstrations of site identification, analysis, design, installation and maintenance of LSF. Methods of site assessment included using geographic information systems (GIS) to assess and measure the site, soil sampling and interpretation of results, assessing vegetation and land use history, assessing the blowing snow problem, developing strategies to overcome site challenges (ditches, trees, utilities), etc.

The fifth and final class was planned to be a winter workshop to observe and discuss functional LSF in the landscape. Scheduling of this tour, so participants from multiple residencies across the state could participate, proved difficult amongst competing and uncertain demands on NYSDOT staff for snow and ice control during the winter. A summer class to observe mature LSF was held instead to accommodate previous participants from various residences attending. The workshop, held in NYSDOT Region 2, consisted of short classroom training in the morning, followed by site visits to four LSF in Region 2 of various ages and vegetation types including willow, evergreen trees and shrubs. Instruction and discussion at each stop focused on the original research conducted as part of this project and how the dynamics of maturing LSF affect snow trapping function over time. This dynamic was illustrated by visiting LSF with a range of ages, plant types, heights and snow storage capacities and explaining how these factors affected the length of the downwind drift and selection of setback distance and other design factors.

Class sizes were planned to be relatively small, up to 25 people in each session. Small class sizes were chosen to allow more interaction and for safety reasons: NYSDOT did not wish to have a large number of people on the right of way. However, more people were able to attend the design class as there was not a safety issue with classroom instruction.

Nearly 110 people attended all of the classes and they helped install four new willow LSF in the landscape in areas known to have blowing snow problems. Feedback received on all the workshops was very positive.

Below is a list of the training workshops undertaken, examples of documentation from the classes, write-ups created after the workshops, field maps and photos of each of the four sites to have a demonstration LSF installed. A brief write-up, link and screenshots of the project website created for information dissemination is also included here.

Class 1: Sessions 1 and 2

NYSDOT Region 3

Tully, New York (Onondaga East Residency)

Design Training, May 27, 2009 College of Environmental Sciences and Forestry Training Center, Heiberg Memorial Forest, Tully, New York

Installation Training, May 28, 2009, West side of Interstate 81, north of Tully exit.

This was the first of the four classes and was held in Tully, New York, south of Syracuse. The class designed and installed a living snow fence on the west side of Interstate 81, for about 1,200 north of the Tully exit.

Class 2: Sessions 1 and 2

NYSDOT Region 5

Design training: October 27, 2009, NYSDOT Regional Offices, Buffalo, New York

Installation training: May 13, 2010, Route 219, Towns of Boston and Concord (Erie South Residency)

Class 3: Sessions 1 and 2

NYSDOT Region 9

Beerston, NY (Delaware South Residency)

Design Training May 25, 2011, Delaware County Soil and Water Conservation District Offices, Walton, New York

Installation Training , May 26, 2011, Route 10, Beerston, New York

Class Four: Sessions 1 and 2

NYSDOT Region 2

Town of Paris (Oneida East Residency)

Design Training October 20, 2011, Regional Crews Conference Room, Utica, New York

Installation Training May 20, 2012, Route 12, Town of Paris

Class Five

NYSDOT Region 2

Field Tour of Existing Living Snow Fences

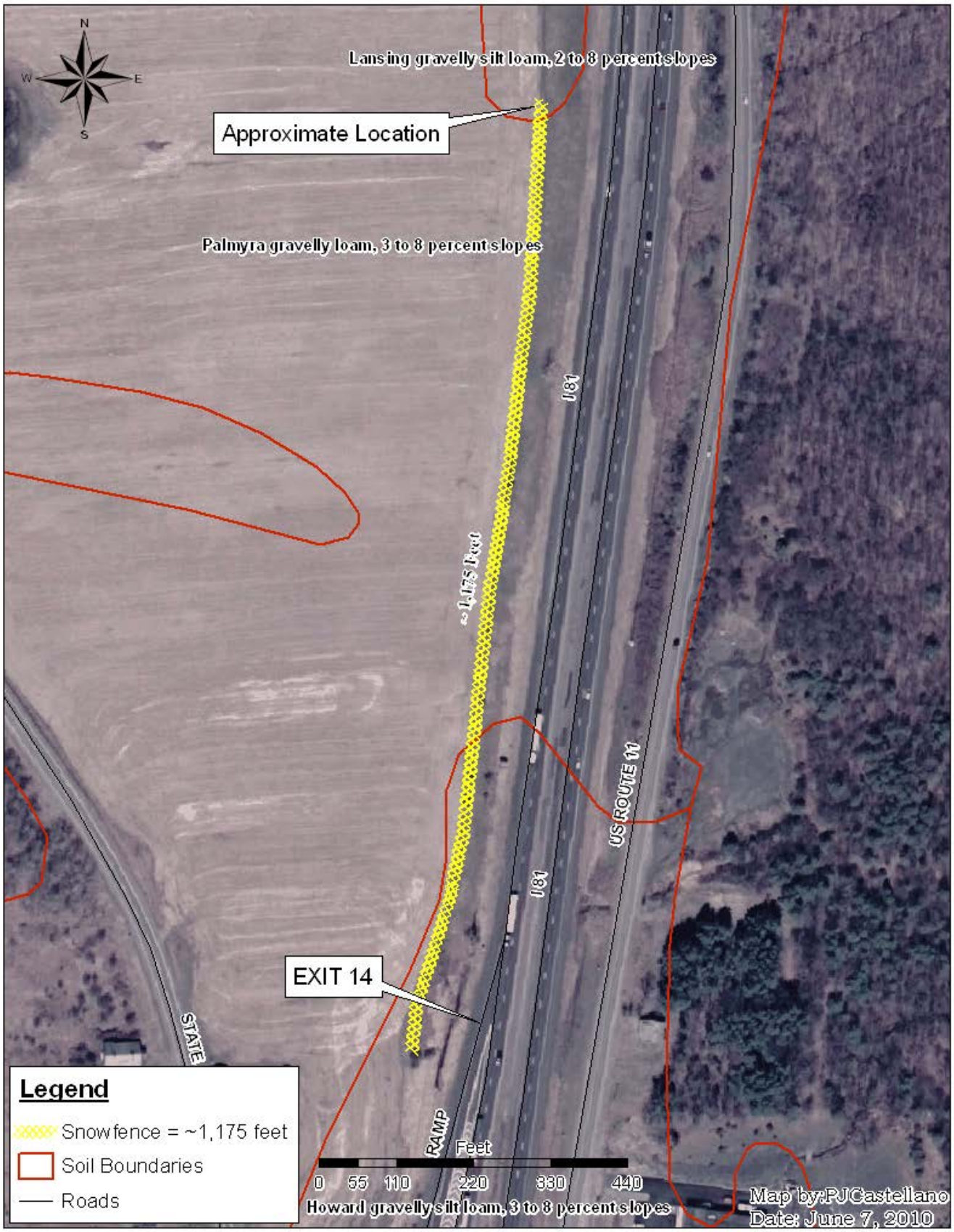
July 25, 2013 (page 177 of 437)

Class 1

Region 3

Tully, NY

2008-2009


N
W
E
S
Lansing gravelly silt loam, 2 to 8 percent slopes
Approximate Location
Palmyra gravelly loam, 3 to 8 percent slopes
I81
~1,175 Feet
US ROUTE 11
I81
EXIT 14
STATE
RAMP
Legend
Snowfence = ~1,175 feet
Soil Boundaries
Roads
Feet
0 55 110 220 330 440
Howard gravelly silt loam, 3 to 8 percent slopes
Map by:PJCastellano
Date: June 7, 2010


EXIT


Living Snow Fence 81S Preble, NY

Class 2

Region 5

Hamburg, NY

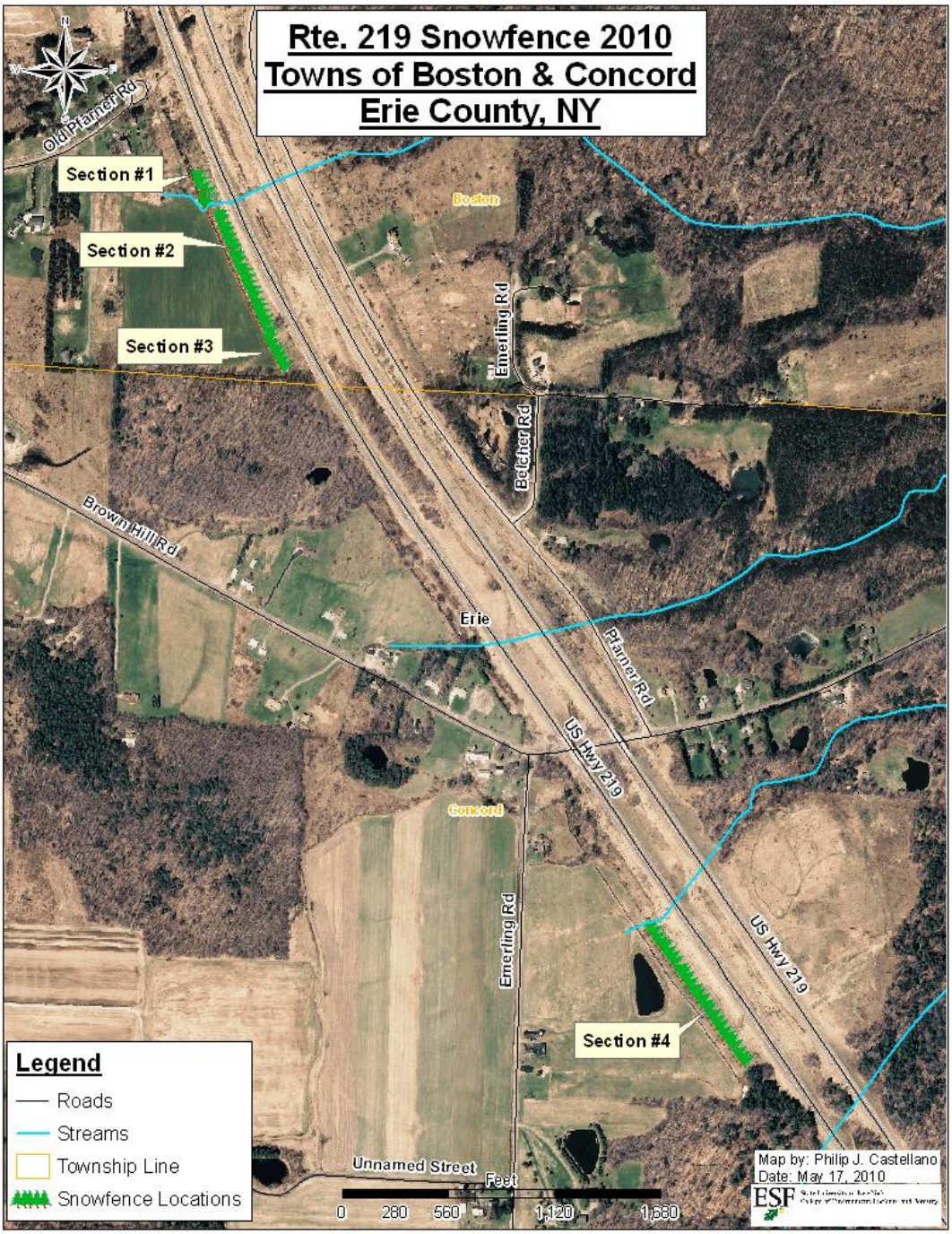
2009-2010

Living Snow Fence Training in Buffalo, NY (May 13, 2010)

On May 13, 2010, Tim Volk, a researcher from the State University of New York's College of Environmental Science and Forestry (ESF) presented the second of two sessions for NYSDOT staff in western New York on how to install living snow fence. The class was a "train the trainer" session; one objective was to provide attendees with enough information so they could provide living snow fence training when they returned to their Region.

Overview:

The aerial photograph below shows the planting design. The northern section in the Town of Boston has three segments. The southern section in the Town of Concord has a single section.



Graphic by P.J. Castellano, College of Environmental Science and Forestry

Installation Training:

This session started in the classroom at NYSDOT's Buffalo Regional Office with an overview of information on successfully installing a living snow fence. After the overview, the class went to two locations on Route 219 and installed much of the living snow fence to that is planned to replace an engineered snow fence.

The left picture shows the northern location on Route 219, in the Town of Boston, about a mile south of Rice Hill Road interchange, where a snow fence will be replaced by a living snow fence using willows.

The right picture shows a location on Route 219, south of Brown Hill Road in the Town of Concord, where snow blows across the highway and causes significant road icing and crashes. At this location, willows will augment an existing snow fence which is 10 feet tall.

Living snow fence with willows is planted in two parallel rows, with plants in each row slightly offset. The offset allows grown plants to overlap, so the snow has no openings to blow through and reach the highway.

Installation begins with site preparation. A planting area is created by removing weeds, and then by tilling the soil. Weeds can be removed with herbicides or mechanical means. The typical herbicide in this situation has glyphosate for an active ingredient and it will take seven to 14 days for the glyphosate to kill the vegetation.

Next, landscape cloth is set down over the tilled area and secured on the edge with dirt. Tractor attachments are available to roll out the landscape cloth and plow a line of earth along each edge to hold down the cloth, but the securing process can also be done manually if equipment is not available.

After landscape cloth is placed, installation proceeds in an assembly-line manner. Two people set the lines for each row of plants. Then, usually in a procession, one or two people use a paint stick to mark the planting spots, people following behind cut an "x" in the fabric for the willow shoots and then people behind them place the willow shoots in the ground.

Cutting an "x" in the landscape cloth is required. A cut in any other shape will result in the cloth constricting the willow trunk and girdling the plant.

After the site is prepared and the willows are planted, workers come along behind and place wood chips. The wood chips are essential to suppress weeds and to provide moisture if the summer is hot and dry.

Tim Volk presents information on living snow fence installation at a pre-job meeting.

The left picture shows the willow shoots, which are about 24 inches in length. They are kept in cold storage until ready to be used, to prevent sprouting before planting.

The right picture shows researcher Eric Fabio distributing willows along the installation area, in advance, to speed planting.

A large amount of wood chips is needed to mulch the willow planting.

Left picture: Philip Castellano, an ESF researcher, helping set the line for planting.
Right picture: Landscape cloth marked with paint for planting. Also, note how tractor attachment anchors cloth with dirt.

Barb Balcerzak, from Erie South Residency, is cutting the landscape cloth with an "x" pattern in advance of planting the willows.

Left and right pictures: depending on the soil, willows may be placed with a mallet or by hand. In the left picture, Tim Volk installs with a mallet; in the right, John Harvey and an unidentified NYSDOT employee install willows by hand.

Below left: Keith Espinosa installs willows by hand.

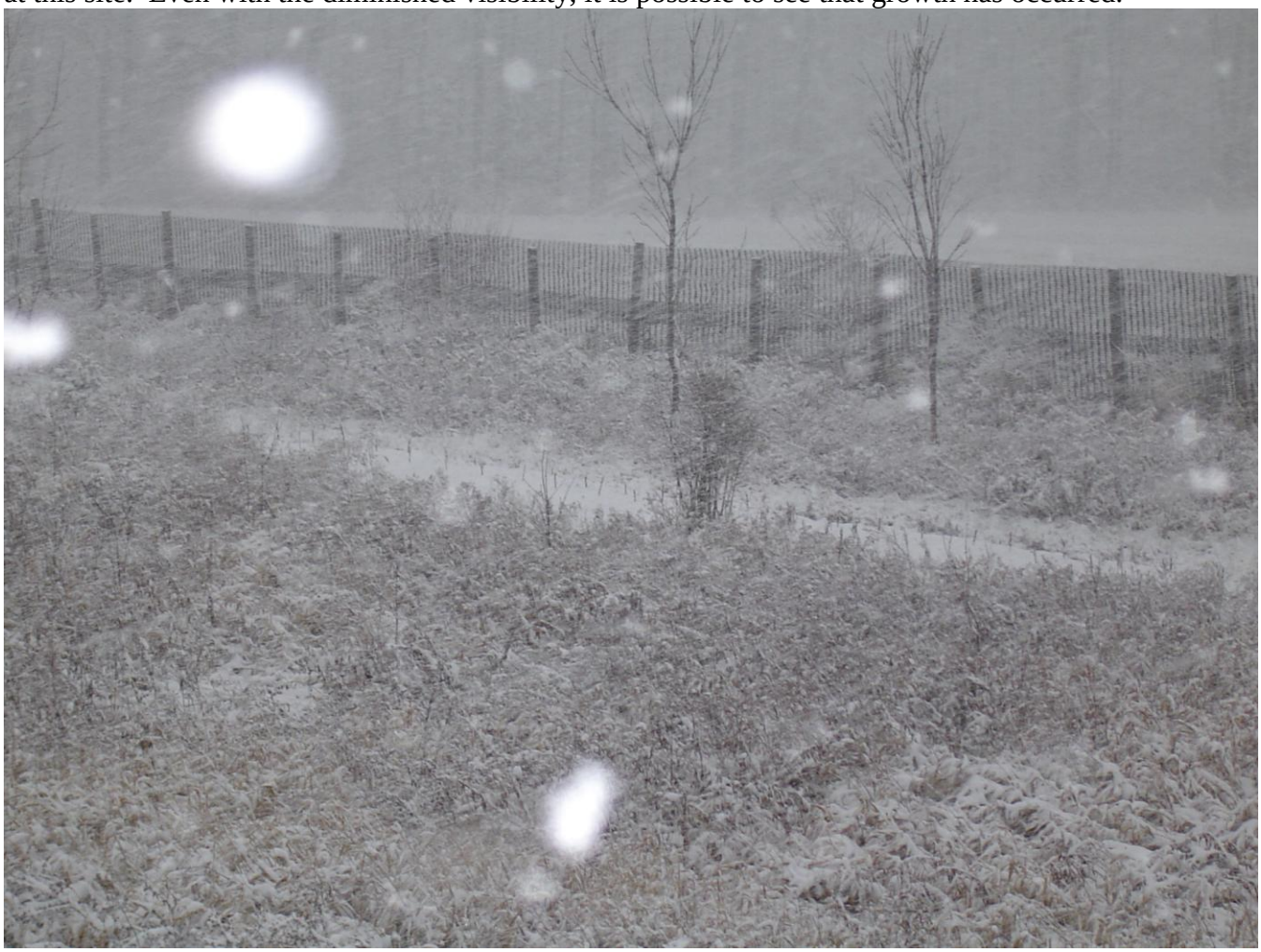
Left picture: Equipment bringing mulch to snow fence from roadside.
Right picture: Erie South Residency staff placing mulch, to suppress weeds and to protect plants during summer.

Note: Thanks also to Erie South Residency staff: Jason Bond, Chris Deci, Ron Donhauser, Dan Perlinger, Frank Pinker, Michael Saldana and Gerry Koch for their assistance with site preparation, planting, work zone traffic control, mulch delivery and operation of equipment.

Living Snow Fence Status Since May, 2010

Here is a picture of the willows immediately after the installation in May, 2010:

Here is a picture of the installation on December 1, 2010. The photograph shows how active the snow is at this site. Even with the diminished visibility, it is possible to see that growth has occurred.



Here are two pictures from June, 2011. Two issues are present in these pictures:

- Growth in the northern segment was diminished by deer eating the willows in some sections of the installation. This is unusual in NYSDOT's experience with willow fences. Growth was relatively even in the southern section, with no apparent deer disturbance.
- Growth of adjoining vegetation provides cover for deer and competes with the willows. As will be seen in the photographs after these, the Residency mowed and addressed this concern.

Left photograph taken in northern segment; right photograph taken in southern section, Town of Concord

The following two photographs were taken in September, 2011. The Residency mowed adjoining vegetation and that is helping with growth. In the northern section (top photograph), some willows have grown quite high but the growth is till uneven because of deer eating some of the willows. In the southern section (bottom photograph), the willows are growing at a consistent rate. The willows are the uniform line of green vegetation in the middle of the photograph, behind the brown grass.

Class 3

Region 9

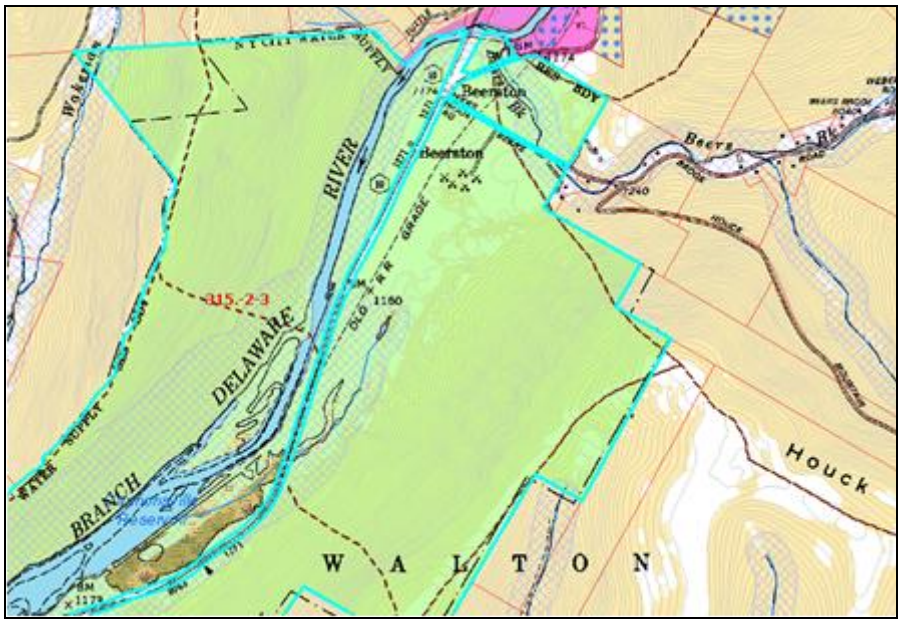
Beerston, NY

2011

Living Snow Fence Training in Beerston, New York, Region 9: Wednesday May 25, 2011 and Thursday May 26, 2011

In late May 2011, Tim Volk, a researcher from the State University of New York's College of Environmental Science and Forestry (ESF) presented the third of four classes on how to design and install living snow fence.

The issues and solutions at the Route 10 site differ from those at sites in the previous two classes, where snow blows from the west across the highway. When snow blows from the west, the solution is to install a living snow fence upwind of the highway, at a sufficient distance from the highway so snow trapped by the fence does not pile up in the travel lanes.



At the Route 10 site, snow blows west to east, across Route 10, from the direction of the West Branch of the Delaware River. Based on observations by the researcher and residency staff, the snow does not pile up on the road as it blows from in this direction.

The prevailing westerly wind hits the hill and Houck Mountain to the east of Route 10 and then blows west, back towards the road. As the snow is blowing back across the road, it accumulates in the travel lanes. Some snow is considered "far snow," when the snow is blown across an open area that is several hundred feet or more. While there may be some "far snow" at this site, the majority of the problem is related to what is called "near snow." When snow is picked up by the wind close to a roadway and deposited on the road, it is referred to as near snow. At the south end of the site, near snow is probably part of the problem because of the embankment of 6 to 12 feet high at the road's edge.

To address this problem, the plan was to install about 1,725 feet of willow cuttings to address the far snow problem. To address the near snow problem at the southern end of the segment, the plan was to plant about potted shrubs from 12 to 18 inches high, in one and two rows for 150 feet at the toe of the embankment at the southern end of the segment.

On Day One, the class convened, in a classroom in the Delaware County Soil and Water Conservation District's headquarters in Walton, New York. Tim Volk provided an overview of the concept of living snow fences and focused on design guidance.

Tim and his colleague Larry Abrahamson finished classroom instruction by lunch time. After lunch, staff met at the living snow fence installation site on Route 10, just south of Beerston.

Looking south, photograph one, below, shows the general area of the plantings, and the hill that reverses the snow back across the road.

The first step in the installation process is to identify the area or areas that will be planted. This is done through the design work explained in the class.

Once the areas to be planted are identified, the next step is to apply an herbicide to kill the vegetation.

Then the installers prepare the soil. The two pictures below show soil preparation. In the first, a tractor with a ripper attachment breaks up the soil and breaks through any hardpan that might be below the soil. It is important to break through the hardpan as willows will be relatively tall and if hardpan prevents the roots from penetrating deep into the ground, the vegetation could topple.

The second photograph shows a rototilling attachment to further smooth out soil. If soil needed amendments, this is the time to undertake the work. Soil amendments were not used at this location.

Photographs above by Justin Heavey,
State University College of Environmental Science and Forestry (SUNY ESF) 2011

In the picture below, the slightly discolored grass on the left side of the landscape cloth shows part of the herbicide treatment to kill the vegetation. A special attachment to the tractor rolled out the landscape fabric and anchored it by tucking it into the dirt on each side of the planting area.

Installation looking north.

Once the landscaping fabric is installed, workers place the unrooted, dormant willow cuttings, using a process similar to a bucket-brigade.

In the first step, workers mark where the cuttings will be placed. As shown in the picture to the left, a straight line, with a rope, is used to mark the rows. Then, as SUNY ESF researcher Justin Heavey is doing in the picture to the right, a worker marks where each willow will be planted.

Next, workers slit the landscape fabric, as Brian Robinson is doing in the picture below, to allow the placement of the willows. The holes must be cut as an "x," otherwise the landscape fabric can girdle the plants as they grow. Each side of "x" should be three to six inches long.

On this installation, Tim Volk purchased a paper-based landscape material, designed to last 18 to 24 months. The hypothesis is that a durable, paper-based material will last long enough to suppress the weeds - - but will decompose and pose no threat to girdling the plants.

The paper-based landscape cloth did not arrive in time for Day One of the installation. It arrived several days later, in time for planting the second set of the willow shoots, near the southern end of the project, and for the plants at the toe of the slope to address the near snow issue.

Paper-based landscape cloth used for willow cuttings.

Paper-based landscape cloth used with plants intended to control near snow.
Photograph by Justin Heavey. SUNY ESF, 2011

After cutting the landscape cloth, workers put a willow in each hole. Half of the willow should be in the ground, half should be exposed. Rick Ostrander, below, is holding a bundle of willows, about 20 inches long, from this installation.

If the soil is soft, one can push in the willow cuttings, as Tom Story and Tim Volk are doing below.

If soil is harder, a few gentle taps with a mallet are needed to get the willow cutting deep enough, as Lewis Lacey and Walter Geidel, Town of Walton Highway Superintendent, are doing.

At the end of the first day, the class installed all the willow cuttings. This photograph, looking north, shows the extent of the installation.

This photograph also shows how field conditions affect installations. The dried weeds on the left of the picture are Wild Parsnip, a noxious weed that can cause skin burns. For this class, the planting was early enough that the threat of Wild Parsnip was not significant and workers avoided easily detectable plants.

Wood chips help suppress weeds and prevent them from overwhelming willow plantings. Most NYSDOT Residencies do not have the equipment, staff or time to water new plantings. Wood chips also serve to retain moisture as the summer progresses.

For this installation, Delaware South and Sullivan Residencies provided about 160 cubic yards of chips to cover the three planted areas.

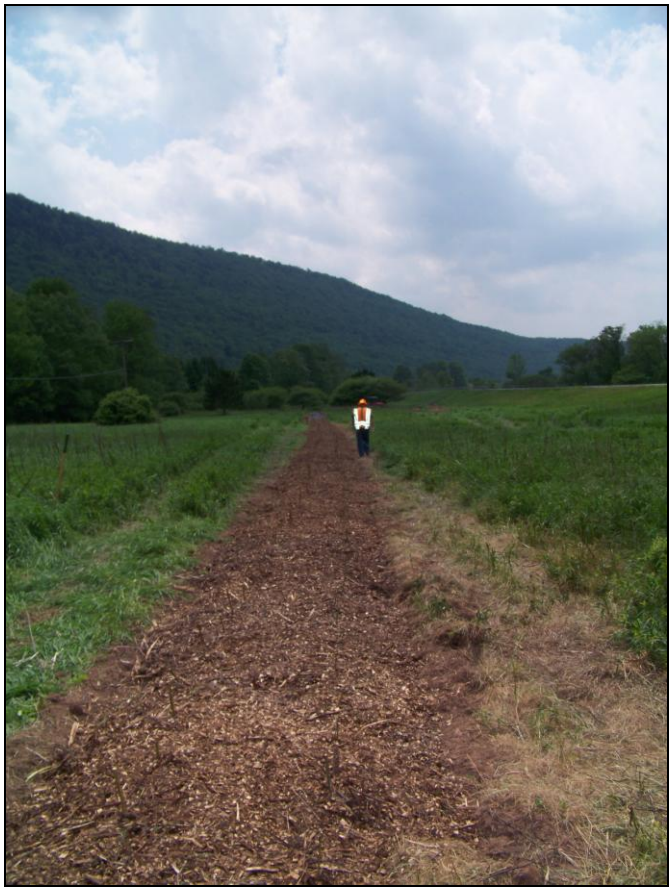
Where site conditions allow, the best practice is to use mechanical equipment to place the chips. For productivity, the largest loader that fits in the setting should be used.

On Day 2 of the class, Steve Dufton, the Delaware South Supervisor for this segment of Route 10, assigned an articulated loader and John Letosky, the operator, to help. The bucket on this loader could hold enough chips to mulch 24 feet of the willow cuttings before returning for another load.

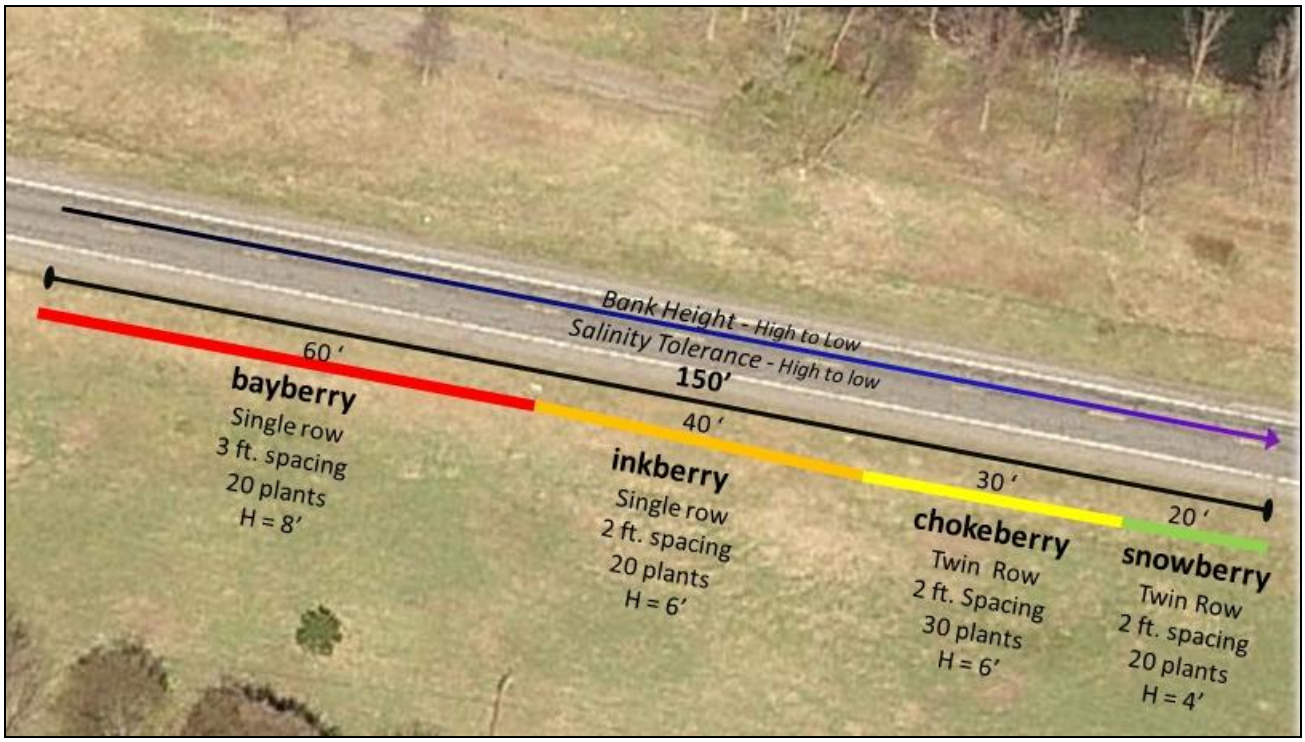
When working with wood chips, it is important to limit the amount of live vegetation in them. A skilled operator will maximize the amount of chips that can be placed in a single trip. In the picture on the left, Tom Story, Everett Cass and Chris Kappeller are unloading chips. In the picture on the right, Peter Norton and Phil Castellano are unloading the chips and trying to keep live vegetation out of the planting.

Once the chips are unloaded, workers need to spread them out, to realize the weed control and moisture retention benefits. These pictures show Brian Robinson, Peter Norton, Lewis Lacey, Tom Story, Bob Richter, Paula Bagley and Everett Cass placing chips.

Here are pictures of the completed work as of Day 2:



To address near snow at the south end of the project, bushes were planted at the base of the highway slope. The researchers developed the following planting plan, to guide the work in the field.



Planting Chart by Justin Heavey. SUNY ESF, 2011

For this installation, the bushes were ordered as potted plants. The benefit is that they are larger and have a higher likelihood of survival once planted. When potted stock is ordered, however, the stock must be kept watered and protected before planting, as is shown in the photograph, below:


Photograph by Justin Heavey. SUNY ESF, 2011

Here is a photograph of the bushes, just after planting, with Justin Heavey in the photograph for scale.

The class

Thanks to good site preparation and regular rain since the installation, the willow cuttings are off to a good start. The top picture shows Mike Darder of Delaware South checking the installation 12 days after planting. Note the leaves starting to appear on the willows. The bottom left photograph shows leaves starting to appear on the second group of willows at 10 days later; the bottom right photograph shows growth at 55 days.

On this page and the following are three panoramic photographs of the willow and bush installation 55 days after the planting. A common factor in all the pictures is good weed control. Below are the bushes at the toe of the slope, looking south

In the photographs below, note good willow survival, good weed control and strong growth in the first 55 days. The lower left picture is looking north at the main willow installation. The lower right photograph is looking south at the installation of the southern rows of willows.

Class 4

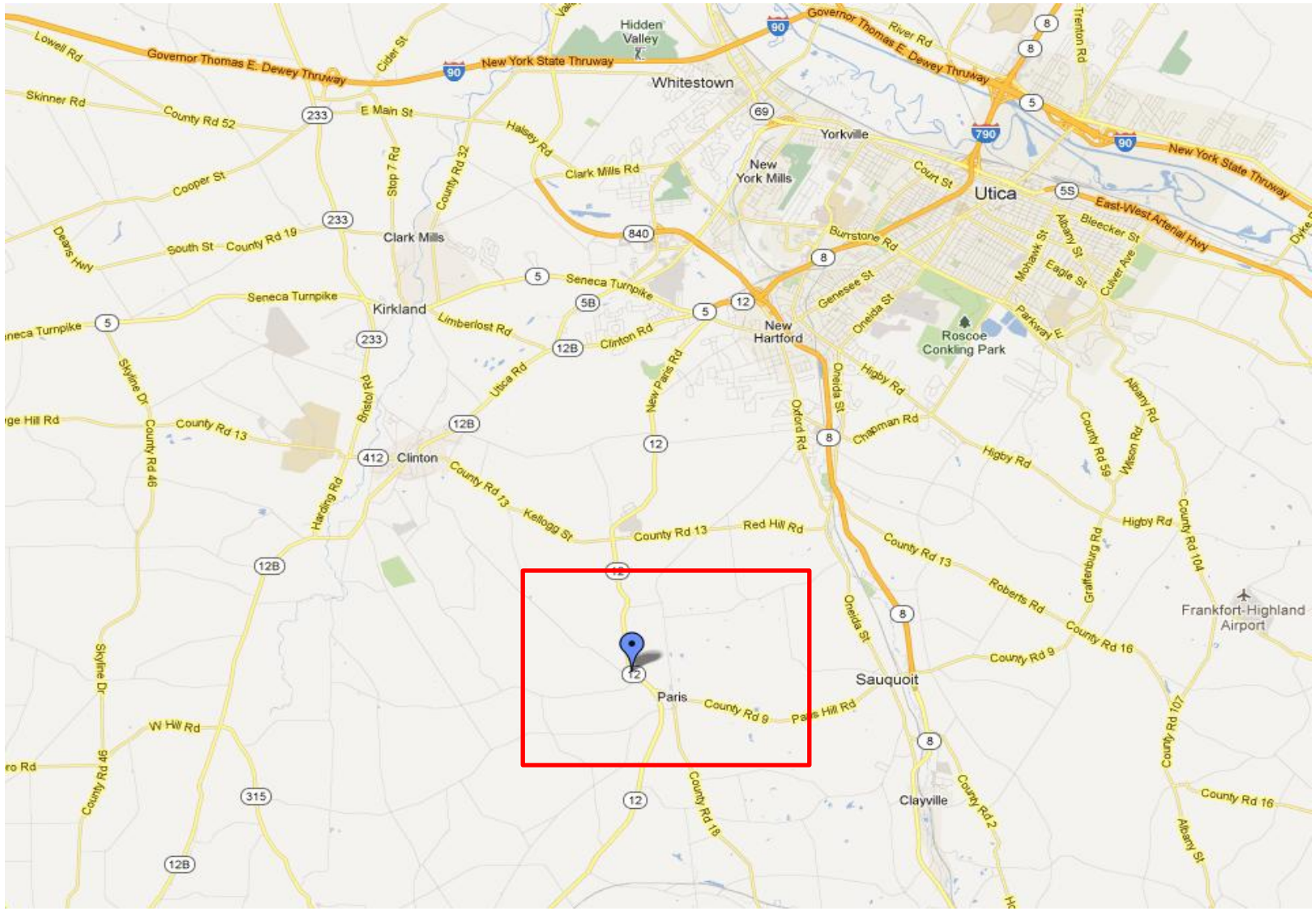
Region 2

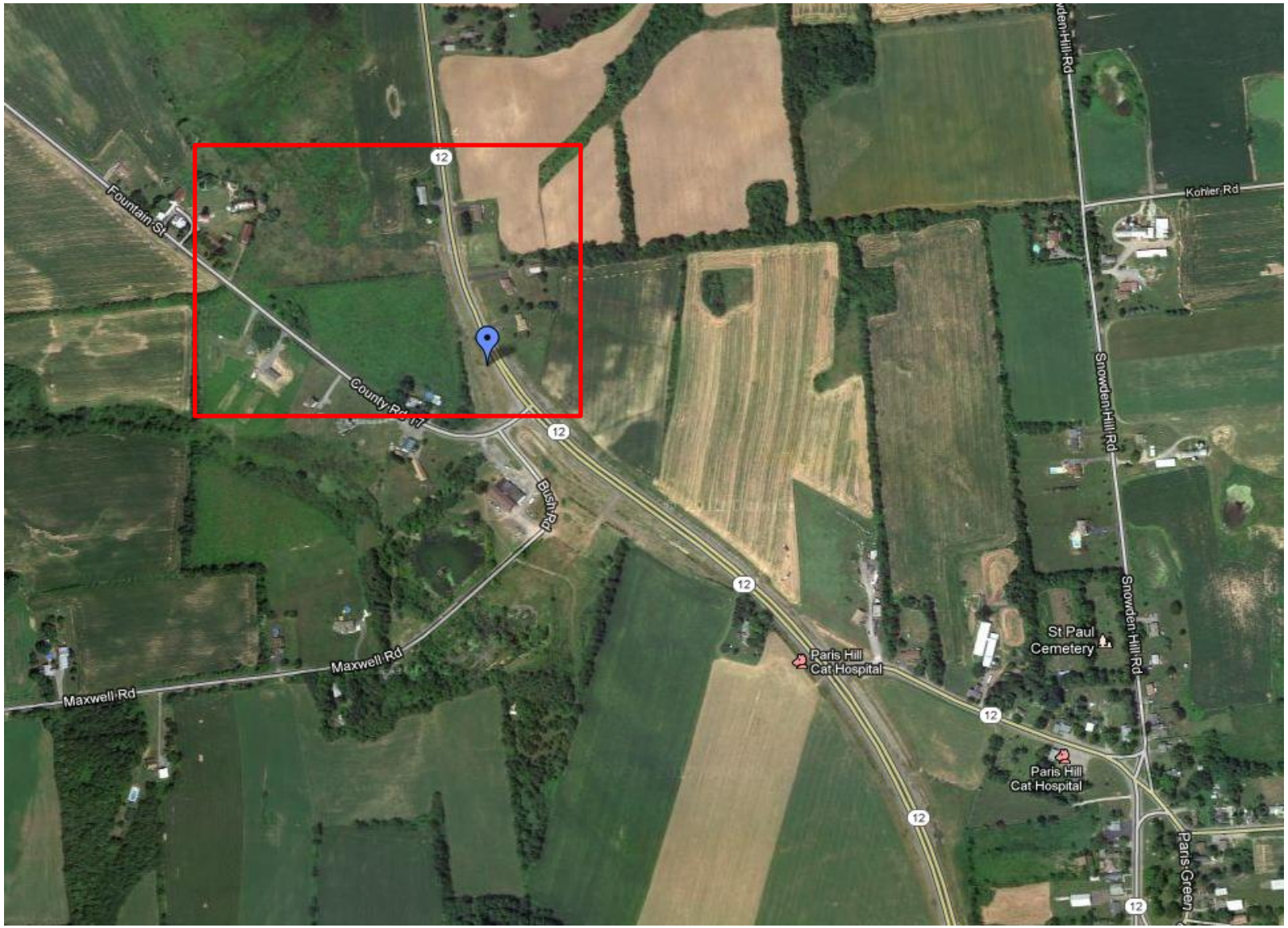
Paris, NY

2012-2013

Willow LSF Installation: Route 12 - Paris, NY

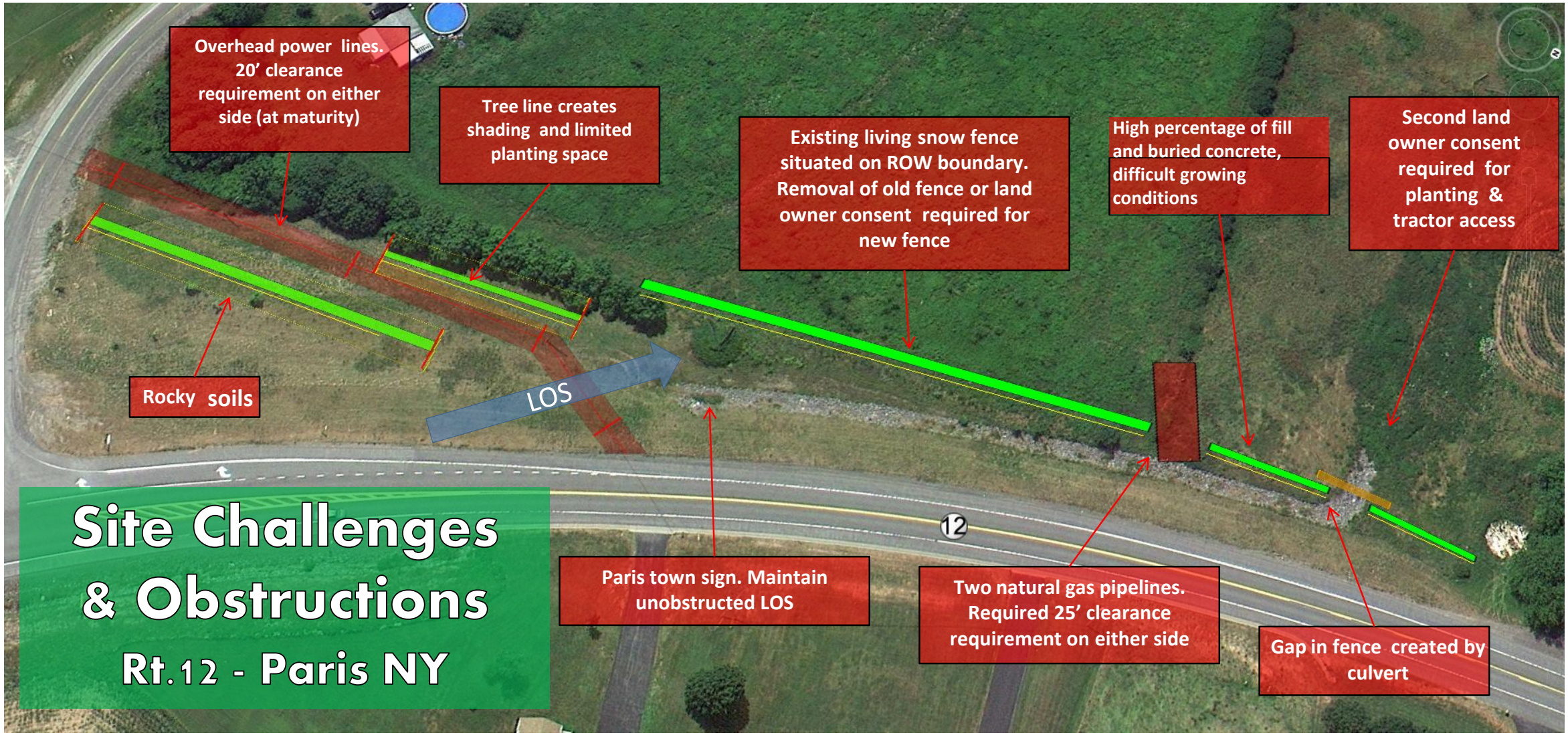
May 2012

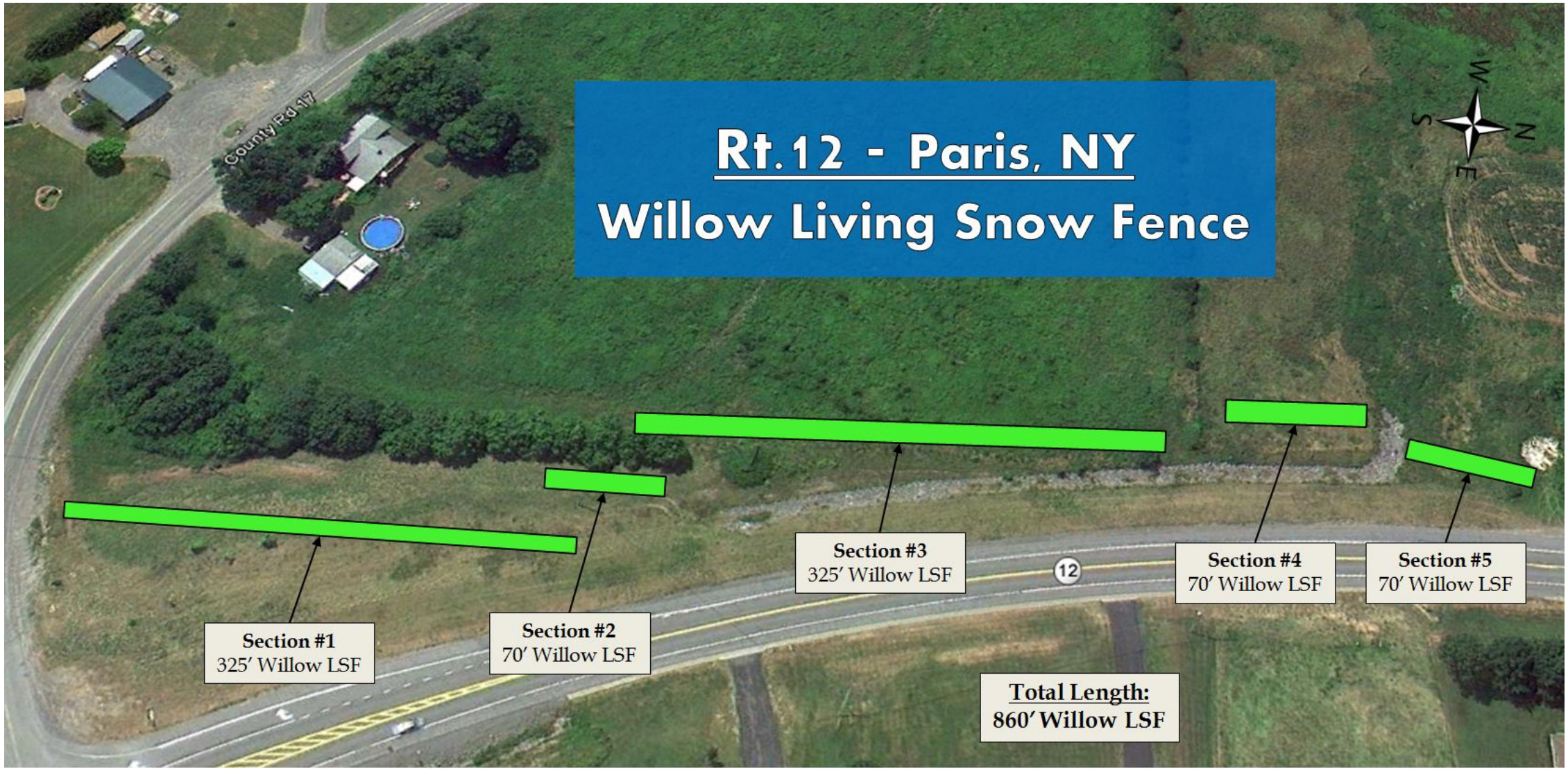

Hidden Valley
Whitestown
Governor Thomas E. Dewey Thruway
New York State Thruway
Lowell Rd
Skinner Rd
County Rd 52
E Main St
Cider St
Halsey Rd
Clark Mills Rd
Cooper St
Stop 7 Rd
County Rd 32
Clark Mills
South St
County Rd 19
Dearis Hwy
Seneca Turnpike
Kirkland
Limberlost Rd
Clinton Rd
Utica Rd
Bristol Rd
Skyline Dr
County Rd 46
County Rd 13
Clinton
Harding Rd
Kellogg St
Red Hill Rd
New Paris Rd
Oxford Rd
Oneida St
Yorkville
New York Mills
Utica
Court St
Burrstone Rd
Genesee St
New Hartford
Roscoe Conkling Park
Parkway
Higby Rd
Chapman Rd
Albany St
Bleecker St
East-West Arterial Hwy
Mohawk St
Eagle St
Culver Ave
Trenton Rd
River Rd
Dyke
Wilson Rd
County Rd 59
County Rd 104
Graffenburg Rd
Roberts Rd
County Rd 16
County Rd 9
Frankfort-Highland Airport
Sauquoit
Paris
Paris Hill Rd
W Hill Rd
County Rd 18
Clayville
County Rd 2
County Rd 107
Albany St
315
233
840
790
69
5S
5B
12B
412


Fountain St
County Rd 11
12
Bush Rd
Maxwell Rd
Maxwell Rd
Paris Hill
Cat Hospital
St Paul
Cemetery
Snowden Hill Rd
Kohler Rd
Paris Hill
Cat Hospital
Paris Green

Working with site conditions…

- Tree line (shade)
- Existing snow fences
- Utilities (electric & gas)
- Rocky soils & fill
- Paris town sign
- Ditches, etc.


Overhead power lines. 20’ clearance requirement on either side (at maturity)
Tree line creates shading and limited planting space
Existing living snow fence situated on ROW boundary. Removal of old fence or land owner consent required for new fence
High percentage of fill and buried concrete, difficult growing conditions
Second land owner consent required for planting & tractor access
Rocky soils
LOS
Site Challenges & Obstructions
Rt. 12 - Paris NY
Paris town sign. Maintain unobstructed LOS
Two natural gas pipelines. Required 25’ clearance requirement on either side
Gap in fence created by culvert
12


Rt.12 - Paris, NY
Willow Living Snow Fence
County Rd 17
W
S
N
E
Section #1
325′ Willow LSF
Section #2
70′ Willow LSF
Section #3
325′ Willow LSF
12
Section #4
70′ Willow LSF
Section #5
70′ Willow LSF
Total Length:
860′ Willow LSF

Class 5

Region 2

Various Locations

August 2013

Research Project C-06-09

Designing, Developing, and Implementing a Living Snow Fence Program for New York State

Workshop 9

Field Tour of Existing Snow Fences

July, 2013

State University of New York
College of Environmental Science and Forestry

New York State Department of Transportation

Justin P. Heavey
Dr. Timothy Volk
Dr. Lawrence Abrahamson

State University of New York – College of Environmental Science & Forestry

John Rowen

New York State Department of Transportation

Background

Blowing and drifting snow can reduce highway safety and increase the costs of snow and ice control. Living snow fences are a means of passive snow control that disrupt wind patterns causing controlled deposition of snow in drifts around the fence before it reaches the roadway. Living snow fences are rows of densely planted trees, shrubs, or other vegetation types that act as a porous barrier to the wind. Living snow fences can consist of any vegetation species or combination of species that possess the key characteristics of sufficient height; growth rates; optical porosity; ground level branching pattern; and the ability to survive and achieve optimal development in the environmental conditions at the snow fence site.

Living snow fences of various vegetation types and planting patterns have been installed in various locations across New York State by NYSDOT over the last decade and longer. In recent years, NYSDOT has also collaborated with SUNY ESF on various tasks related to living snow fences as part of research project C-06-09. This project has included basic and applied research aimed at improving the design, installation, and management of living snow fences, and the transfer of this technology to NYSDOT residencies and staff across the state. Eight living snow fence design and installation workshops have been conducted in previous years as part of this project, resulting in the installation of four new living snow fences.

This current workshop is the ninth and final workshop of this project, and is intended to give participants an overview of living snow fence growth and function in the years following installation, and engage participants in discussions about design decisions, fence placement and planting patterns, species, challenges encountered and lessons learned, development and function of living fences over time, and any other pertinent information related to living snow fence plantings. This workshop was originally intended as a winter tour to observe and discuss snow fences in the context of observed snow drifts, but lack of a consistent snow fall and scheduling of NYSDOT snow and ice control staff in the winter months has made a winter workshop with adequate participation difficult to accommodate. The same general purpose of a winter tour is intended for the current workshop however, and the same topics of snow fence function can be discussed in terms of observations of key variables of fence height and porosity, which drive snow trapping function. The consultant SUNY ESF has provided summaries of data from each of the four fences visited in this workshop, which was collected in the preceding winter (2012/2013), to facilitate a more informed and detailed discussion on the structure and function of these living snow fences. Four living snow fences were identified for this workshop and information on each fence is provided in the following pages. A regional map and a proposed route and directions to each site, starting from Oneida East Residency, are provided at the end of this handout. Also provided are summaries of data collected from a larger statewide sample of living snow fences, the models of snow trapping function used in this analysis, and sources of more information.

Stop #1: One year old shrub-willow living snow fence

Route 12 SB Paris, NY Region 2 Oneida County Approximate reference marker: 12 260 41119 Nearest crossroad: Fountain St

Site History: NYSDOT and SUNY ESF collaborated to install a shrub-willow living snow fence on Route 12 in Paris, NY in May 2012. The plants in this location have shown excellent growth and survival rates over the first growing season. The fence is on track to achieve functional height and porosity levels by the second or third winter after planting, largely a result of thorough site preparation and follow-up maintenance. The site had several design challenges and planting obstructions that had to be addressed (see diagram on page 5). Some non-traditional site preparation and maintenance techniques have also been implemented at this site.

Planting Information

Year Installed	Fence Age	Vegetation Type	Species/Cultivar	Plant Spacing	Number of rows	Row Spacing	Fence Length	Fetch Distance
2012	**1**	**shrub-willow**	**varieties "SX64" and "Fishcreek"**	**2 ft**	**2**	**2.5 ft**	**5 Sections Total 860 ft**	**900 ft**

Snow Trapping Function (Winter 2012/2013*)

Fence Height	Observed Porosity	Snow Storage Capacity of Fence	Annual Snow Transport at Site	Minimum height requirement	Fence Setback Distance	Required Setback at minimum fence height	Predicted drift length at current height and porosity
5 ft	**90%**	**<1 ton/ft**	**3 tons/ft**	**4 ft**	**85 ft**	**100 ft**	**110 ft**

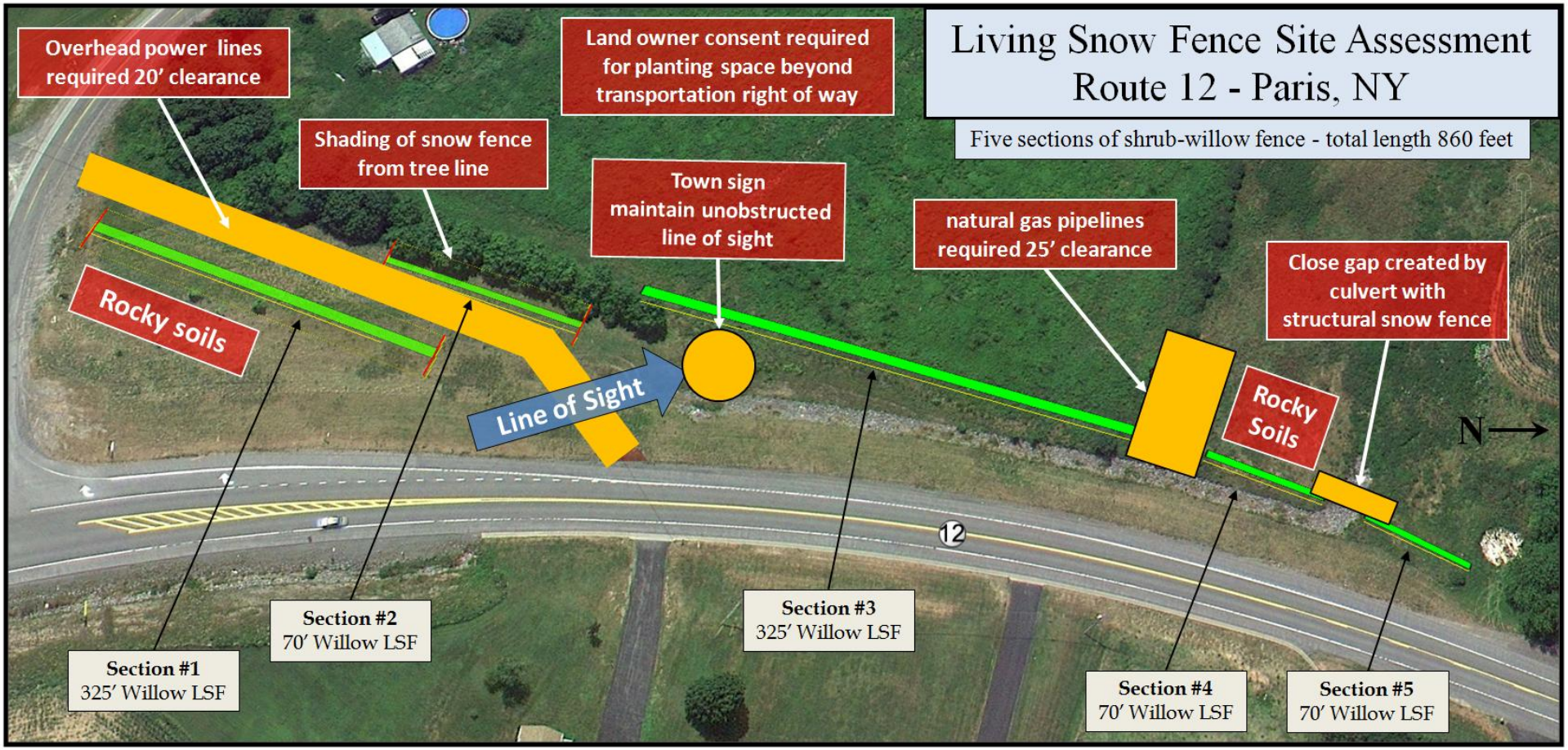
*Note: Fetch, setback, height, porosity, and capacity values represent measurements taken on section #3 in winter 2012/2013. Numbers rounded for clarity.

Discussion Topics

- Structure and Function over time
  - (See Figures 10 – 14)
- Installation, monitoring, and maintenance
  - Mowing & deer repellent
- Design challenges and solutions
- Biodegradable landscape fabric & pins
- Coppicing or not (benefits/drawbacks)

Figure 1: Shrub-willow snow fence at Route 12 Paris in May, 2013 - Photo by Justin Heavey

Figure 2: Aerial photo showing locations of shrub-willow snow fence sections planted along Route 12 in Paris, NY



Figures 3: Diagram of fence sections and site challenge for Paris, NY. Diagram by Justin Heavey

Stop #2: Three year old Norway spruce living snow fence

Route 28 SB Columbia, NY Region 2 Herkimer County Approximate reference marker: 28 2304 1067 Nearest crossroad: Horseshoe Lane

Site History: This living snow fence was planted in approximately 2010 by NYSDOT, replacing a structural fence installation. The fence has good height growth, low porosity, and 100% survival. It has one relatively short section, and a dense triple row planting pattern. Fence is installed on private property. A five year land easement was arranged with the land owner after a visualization of the fence was provided. Fence has been reported work well by local NYSDOT staff.

Planting Information

Year Installed	Fence Age	Vegetation Type	Species/Cultivar	Plant Spacing	Number of rows	Row Spacing	Fence Length	Fetch Distance
2010	**3**	**Evergreen tree**	**Norway spruce**	**10 ft**	**3**	**7 ft**	**220 ft**	**2000 ft**

Snow Trapping Function (Winter 2012/2013*)

Fence Height	Observed Porosity	Snow Storage Capacity of Fence	Annual Snow Transport at Site	Minimum height requirement	Fence Setback Distance	Required Setback at minimum fence height	Predicted drift length at current height and porosity
9 ft	**30%**	**20 ton/ft**	**5 tons/ft**	**4 ft**	**170 ft**	**140 ft**	**40 ft**

*Note: height, porosity, and capacity values represent measurements taken in winter 2012/2013. Numbers rounded for clarity.

Discussion Topics

-Norway spruce for living snow fences
-Density of conifer fences
-Number of rows
-Amount of space required
-Setback distance
-Size of trees at installation
-Rapid functionality (landscape effect)
-Performance of living fence compared to structural
-Successfully working with landowners for living snow fences

Figure 4: Norway spruce living snow fence in winter 2012/2013 - Photo by Justin Heavey

North^

Figure 5: Aerial photo of Norway spruce fence along Route 28 Columbia, NY

Stop #3: Eight year old honeysuckle shrub living snow fence

Route 167 SB Manheim, NY Region 2 Herkimer County Approximate reference marker: 167 2302 3024 Nearest crossroad: Lamanna Rd

Site History: This living snow fence was planted in approximately 2005 by NYSDOT. The fence has shown fair height growth and high survival, but optical porosity is higher than desired. Land for planting was acquired through a verbal agreement with the land owner. NYSDOT landscape architects designed and installed the fence. Fence has been reported work well by local NYSDOT staff.

Planting Information

Year Installed	Fence Age	Vegetation Type	Species/Cultivar	Plant Spacing	Number of rows	Fence Length	Fetch Distance
2005	**8**	**Ornamental shrub**	**Arnold's Red Honeysuckle**	**3 ft**	**1**	**600 ft**	**675 ft**

Snow Trapping Function (Winter 2012/2013*)

Fence Height	Observed Porosity	Snow Storage Capacity of Fence	Annual Snow Transport at Site	Minimum height requirement	Fence Setback Distance	Required Setback at minimum fence height	Predicted drift length at current height and porosity
7 ft	**60%**	**15 ton/ft**	**2 tons/ft**	**3 ft**	**125 ft**	**80 ft**	**25 ft**

*Note: height, porosity, and capacity values represent measurements taken in winter 2012/2014. Numbers rounded for clarity.

Discussion Topics

-Ornamental shrubs
-Bottom gap
-Single row
-Size of planting stock used
-Cornfield planting

Figure 6: Honeysuckle living snow fence in winter 2012/2013 - Photo by Justin Heavey

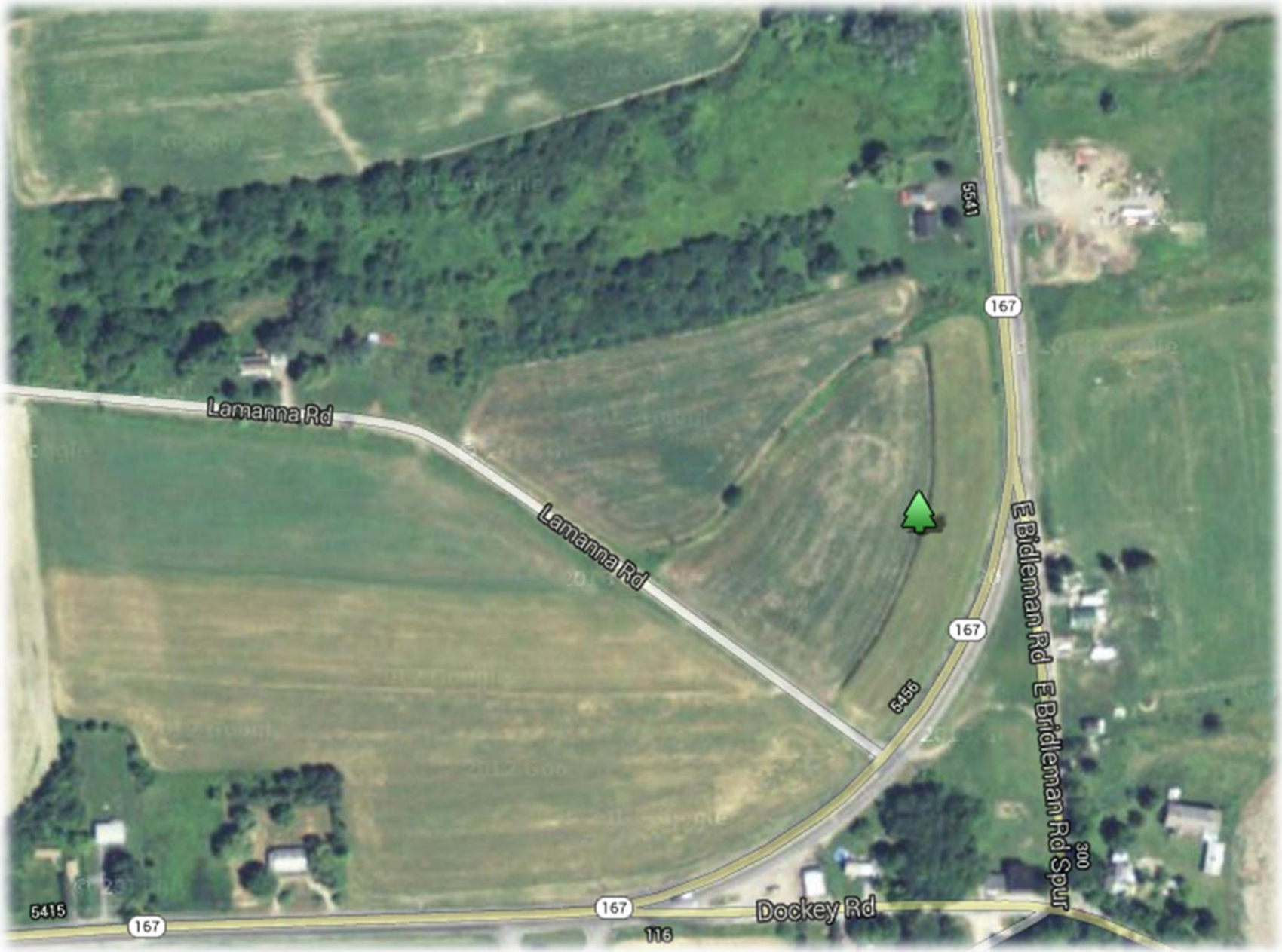


Figure 7: Aerial photo of honeysuckle living snow fence along Route 167 in Manheim, NY

Route 167 SB Manheim, NY Region 2 Herkimer County Approximate reference marker: 167 2302 3044 Nearest crossroad: Bronner Rd

Site History: This living snow fence was installed in approximately 1982 and is one of, if not the largest and oldest living snow fence in the state. This presents an interesting and unique opportunity to observe a fence planted with large growing evergreen trees, many years after planting. Land for this fence was acquired and design was conducted via a highway reconstruction project. Fence has been reported work well by local NYSDOT staff.

Planting Information

Year Installed	Fence Age	Vegetation Type	Species/Cultivar	Plant Spacing	Number of rows	Row Spacing	Fence Length	Fetch Distance
1982	**31**	**Evergreen tree**	**Norway spruce and white spruce**	**25 ft**	**2**	**10**	**600 ft**	**2500 ft**

Snow Trapping Function (Winter 2012/2013*)

Fence Height	Observed Porosity	Snow Storage Capacity of Fence	Annual Snow Transport at Site	Minimum height requirement	Fence Setback Distance	Required Setback at minimum fence height	Predicted drift length at current height and porosity
45 ft	**5%**	**400 ton/ft**	**5 tons/ft**	**4 ft**	**110 ft**	**135 ft**	**20 ft**

*Note: height, porosity, and capacity values represent measurements taken in winter 2012/2013. Numbers rounded for clarity.

Discussion Topics

-Oldest known living snow fence?
-Originally intended as living snow fence?
-Large plant spacing
-Species selection
-Capacity/transport ratio and porosity
-Drift length
-Space requirements

Figure 8: Norway and white spruce living snow fence in fall 2012 - Photo by Justin Heavey

Figure 9: Aerial photo of Norway spruce and white spruce living snow fence along Route 167 in Manheim, NY

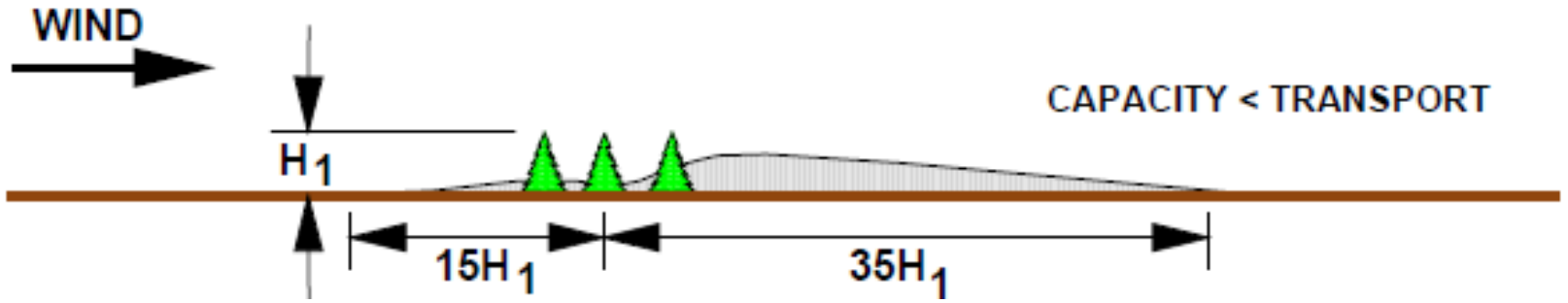


Figure 10: When fence capacity is *less than or equal to snow transport*, the drift length extends to the maximum distance of 35H, or thirty five times the height of the fence
Diagram from (Tabler 2003)

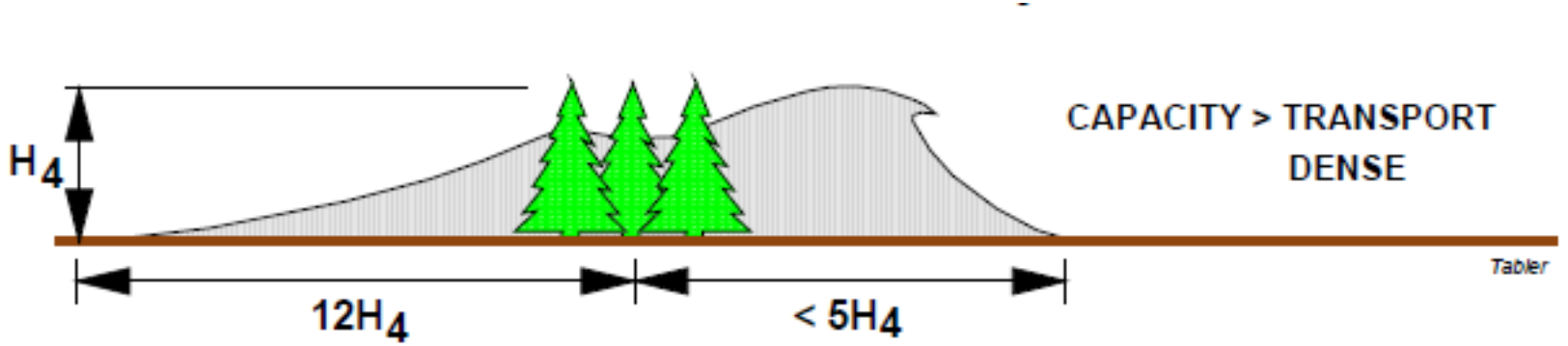


Figure 11: When fences mature and grow to large heights, fence **capacity becomes greater than snow transport**, the drift is reduced to some fraction of the maximum, and the setback distance can be less than 35H
Diagram from (Tabler 2003)

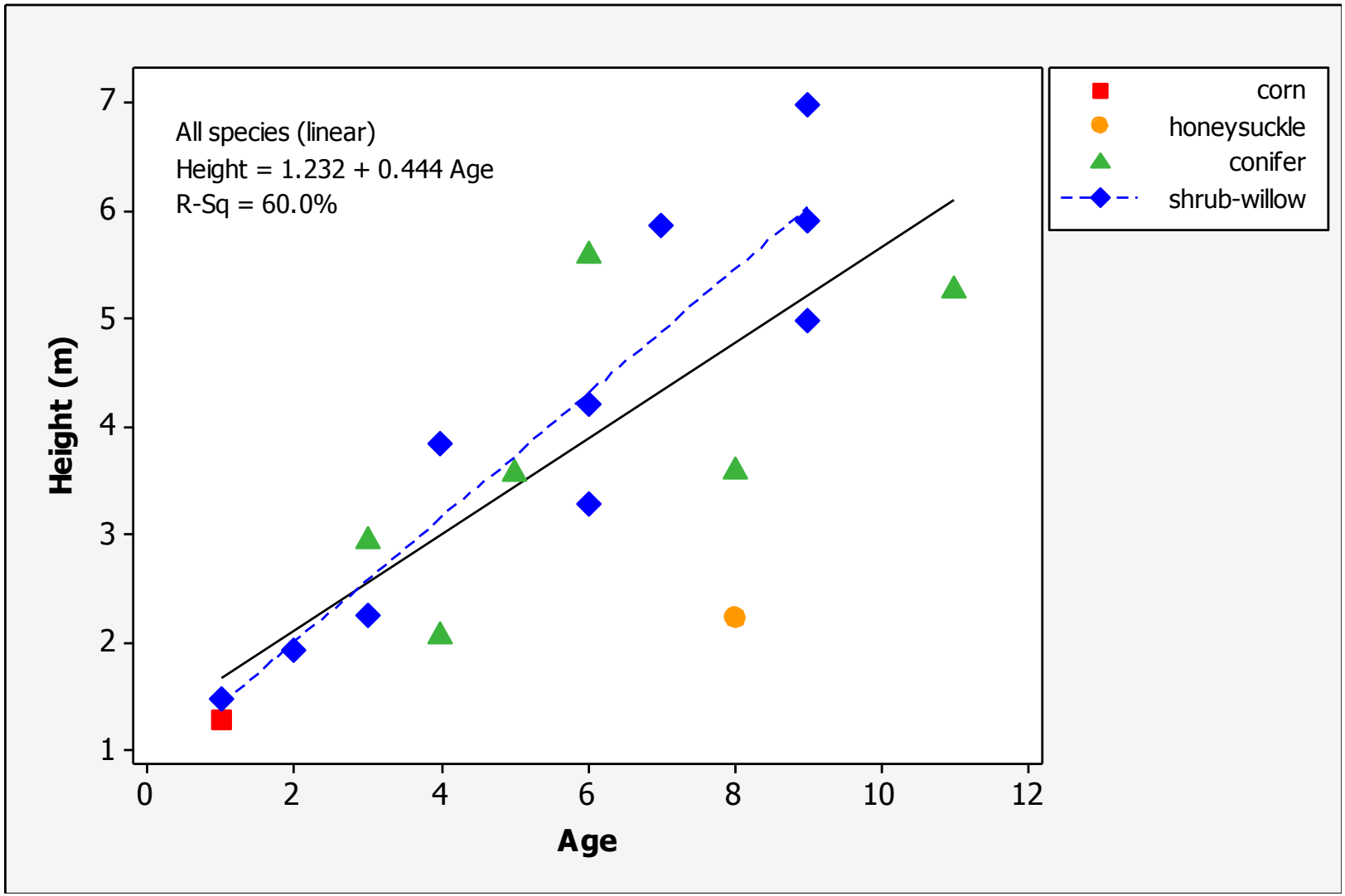


Figure 12: Age versus height (in meters) of 18 living snow fences of various species in New York State, grouped by vegetation type. Height increases linearly with time when best management practices are employed.
Graph by Justin Heavey

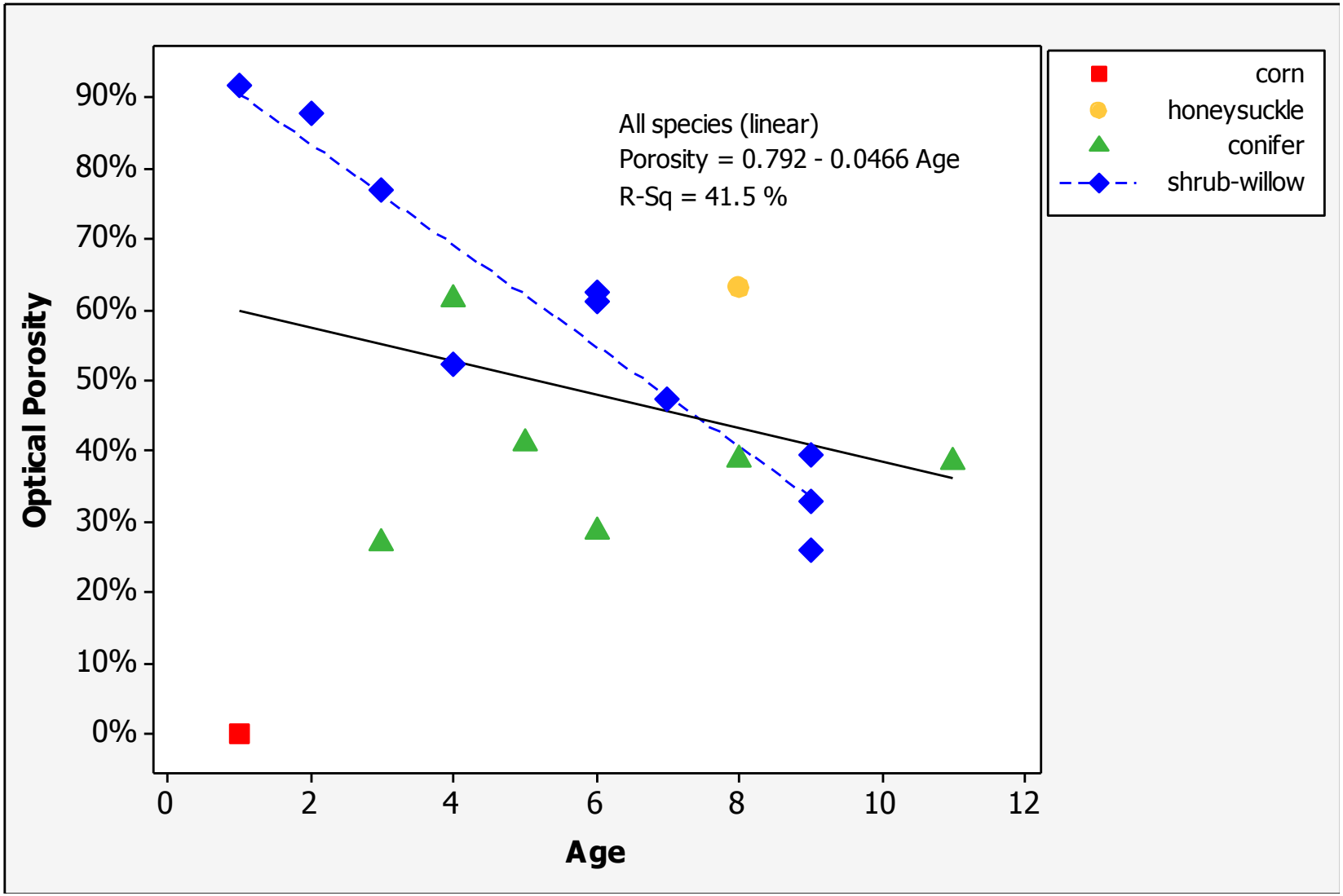


Figure 13: Age versus optical porosity of 18 living snow fences of various ages and species in New York State grouped by vegetation type. Porosity decreases linearly with age when best management practices are applied.
Graph by Justin Heavey

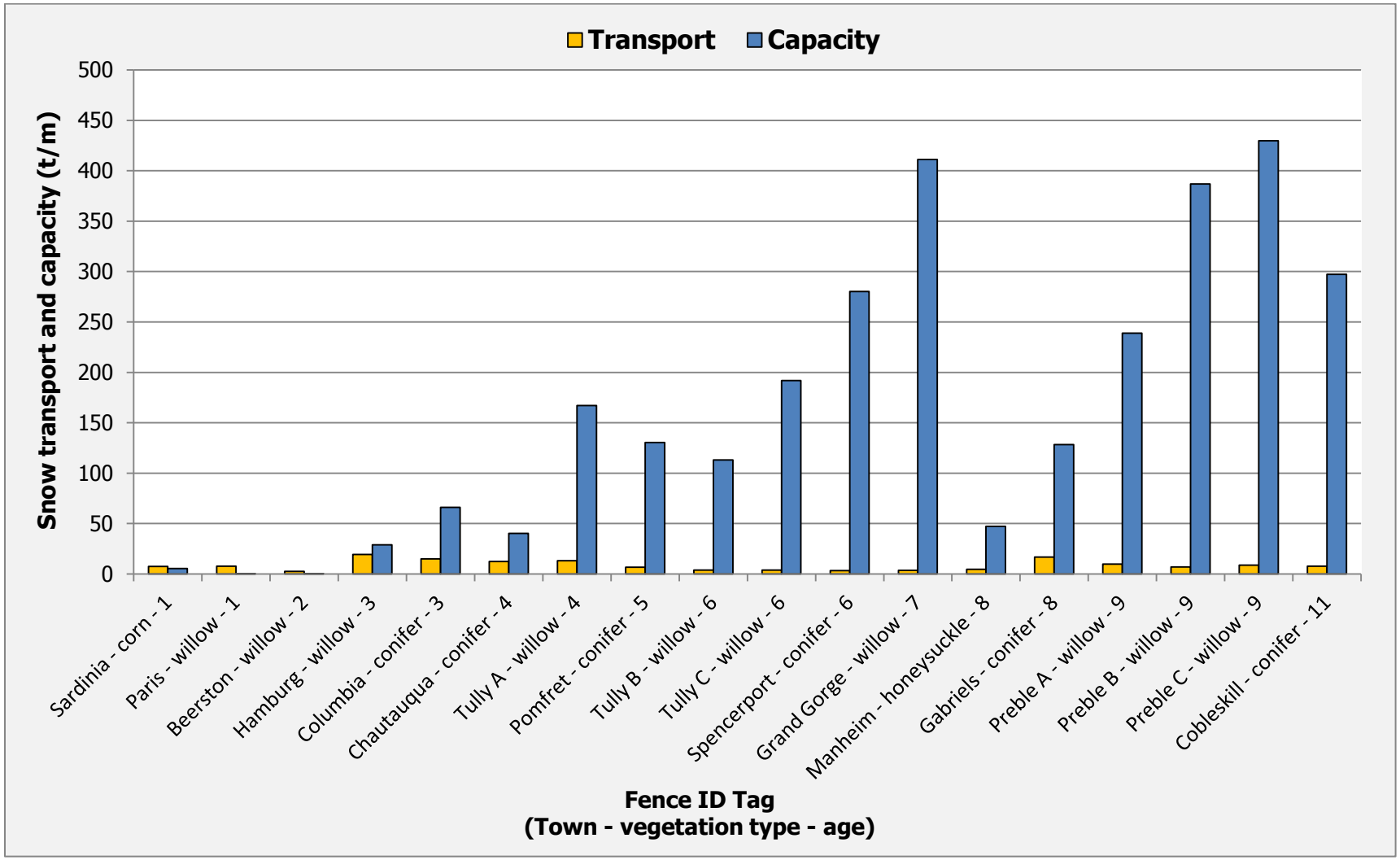


Figure 14: Fence capacity relative to the quantity of snow transport at each site for 18 living snow fences of various species and ages in New York State. Capacity greatly exceeded transport for all fences age three and older.

Chart by Justin Heavey

Models and Sources

Average Annual Snow Transport in New York State (**Q**)

$$\mathbf{Q} = 1500(0.17)(\mathbf{S_{we,AS}})(1\text{-}0.14^{\mathbf{F}/3000})$$

Where:
Q is average annual snow transport in t/m
(0.17) is the assumed snow relocation coefficient ($\mathbf{C_r}$)
($\mathbf{S_{we,AS}}$) is the water equivalent of snowfall over the accumulation season in meters
F is the fetch distance in meters

Snow Storage Capacity of a living snow fence ($\mathbf{Q_c}$)

$$\mathbf{Q_c} = (3 + 4\mathbf{P} + 44\mathbf{P}^2 - 60\mathbf{P}^3)\ \mathbf{H}^{2.2}$$

Where:
$\mathbf{Q_c}$ is the snow storage capacity of the fence in units of t/m
P is the observed optical porosity value of the fence
H is observed height of the fence in meters

Required Height of the fence ($\mathbf{H_{req}}$)

$$\mathbf{H_{req}} = (\mathbf{Q}/8.5)^{0.455}$$

Where:
$\mathbf{H_{req}}$ is the required height of the fence in meters
Q is the average annual transport in t/m

Predicted Setback distance ($\mathbf{D_{35}}$)

$$\mathbf{D_{35}} = (\sin\boldsymbol{\alpha})35\mathbf{H_{req}}$$

Where:
$\mathbf{D_{35}}$ is the predicted setback distance in meters
$\boldsymbol{\alpha}$ is the degrees of the prevailing winter wind angle relative to the roadway. $\boldsymbol{\alpha}$ was assumed to be 90^o in all cases
$\mathbf{H_{req}}$ is the required height of fence in meters

Predicted Drift Length of the downwind drift

$$\mathbf{L} = \{[10.5 + 6.6(\mathbf{Q}/\mathbf{Q_c}) + 17.2(\mathbf{Q}/\mathbf{Q_c})^2]/34.3\}(12 + 49\mathbf{P} + 7\mathbf{P}^2 - 37\mathbf{P}^3)(\mathbf{H_{req}})$$

Where:
L is the length of the downwind drift in meters
Q is the estimated snow transport at the fence in t/m
$\mathbf{Q_c}$ is the estimated fence capacity in t/m
P is the observed fence porosity
$\mathbf{H_{req}}$ is the required height of the fence based on the transport quantity (**Q**)

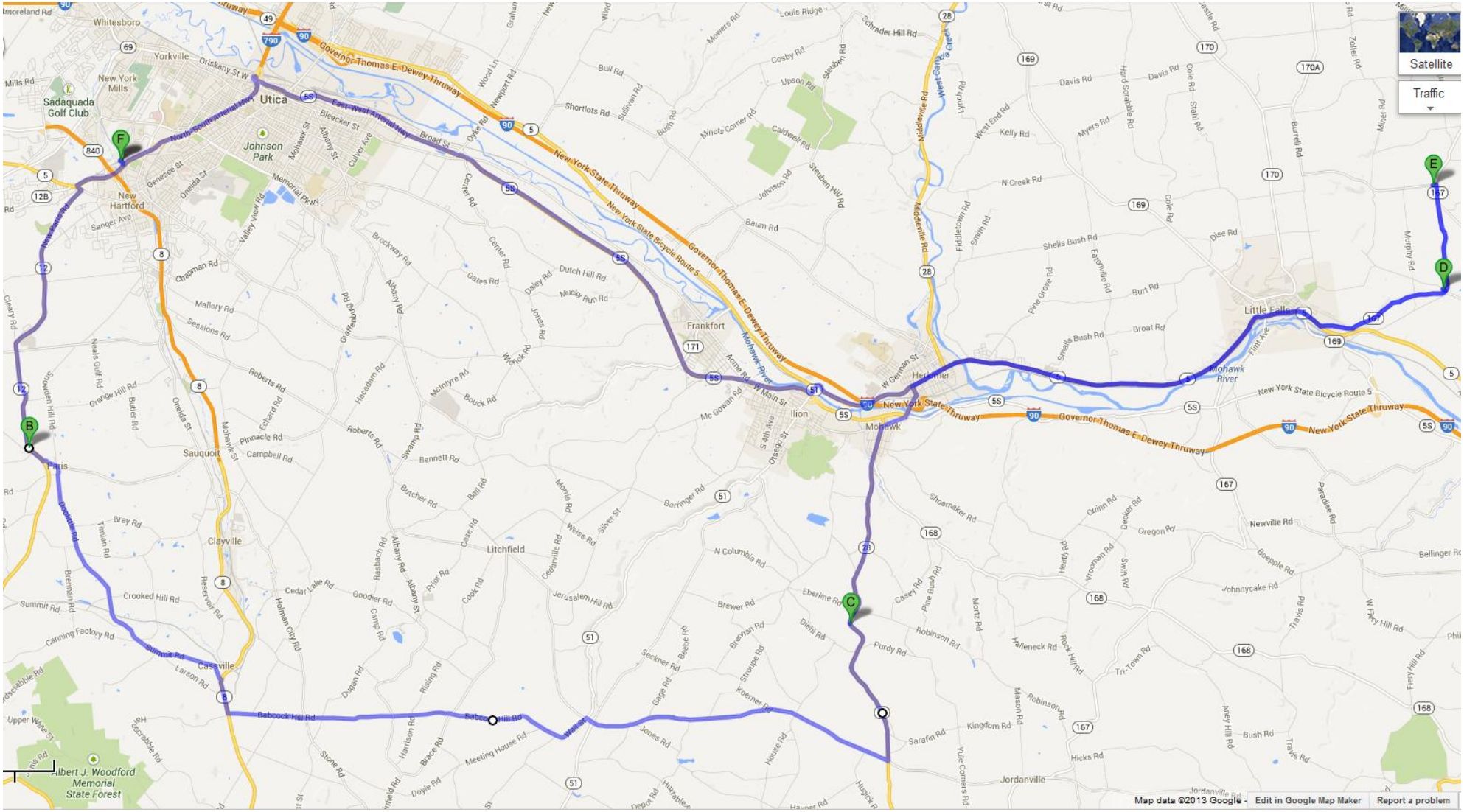
Sources:

Tabler, R.D. 2000. *Climatological analysis for snow mitigation in New York State.* Tabler and Associates. Niwot, CO.

Tabler, R.D. 2003. *Controlling blowing and drifting snow with snow fences and road design.* Tabler and Associates. Niwot, CO.

More information and resources for living snow fences is available online at www.esf.edu/willow

Google Map of Suggested Workshop Tour Route



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Project Website

www.esf.edu/willow/lsf

As the final subtask of Task 2, a webpage was created and hosted by SUNY-ESF. This website provides an introduction to LSF and the work conducted in this project; photo slideshows of the trainings and installation of LSF; photos of LSF throughout NYS studied in Task 3; and links to the fact sheets, presentations, cost benefit model and other materials produced in this project. The website can be accessed by NYSDOT employees and the general public at (www.esf.edu/willow/lsf). Screen shot of the website are provided below.