Maidstone Slide – STP 0271 (20)

Year 3 Report

Wetland and Invasive Species Monitoring and Control Recommendations

December 11, 2015

Marc Lapin, Ecosystem Conservation Science

239 Cider Mill Road, Cornwall, VT 05753

and

Mary Nealon, Bear Creek Environmental, LLC

149 State Street, Suite 3, Montpelier, VT 05602

Table of Contents

Tables

Figures

Appendix 1 – Photographic Documentation

Executive Summary

A third year of monitoring of the wetland impacted by the construction of a temporary access road was conducted in accordance with the Invasive Species Management, Planting and Monitoring Plan[1] for the Maidstone STP 0271(20) project. The temporary access road was constructed during spring 2013 and was restored following construction. During late September 2013, observation plots were used to assess the overall vegetative success in the restored wetland and the presence/absence of invasive species. In mid-August 2014 and again in mid-August 2015 the same plots were resampled. Year 3 assessment of site stability, wetland hydrology and wetland function was made by ecologist Marc Lapin.

Evaluation of Vegetative Success

In the third year of monitoring we saw noteworthy changes in the plant species composition of both plots and this is seen as a general shifting and sorting out along the entire restored roadway. There are two categories of species that have decreased in abundance or disappeared entirely from the restoration rate. The first category is species that prefer disturbed or open-ground and do not persist long in the face of competition from more robust species. The second category includes select species that were part of the seed mix but apparently are not currently as competitive as other species. As in previous years, the wetland area disturbed by the construction of the access road appeared stable and showed successful revegetation with a species variety overwhelmingly dominated by natives. Vegetation cover was again estimated to be over 90 percent, with little change in total plant cover from Year 2.

[1] Bear Creek Environmental, LLC. Biological Services Team. 2012. Invasive Species Management, Planting and Monitoring Plan for Maidstone STP 0271(20). Vermont Agency of Transportation-Slope Failure on VT Route 102 Adjacent to Connecticut River. Montpelier, Vermont.

Assessment of Invasive Species

A few individual invasive exotic shrubs were found in or directly adjacent to the re-vegetated area. Both glossy buckthorn and Eurasian honeysuckle were in the area and were flagged for chemical control. Compared to Years 1 and 2, a smaller number of non-native herbaceous species was recorded for the restored area; none of these species are listed in Vermont or New Hampshire as invasive species. Control of wild parsnip by hand pulling and chemical control of glossy buckthorn and Eurasian honeysuckles in the roadway margin and along the stabilized slope were again conducted during the 2015 growing season. Less wild parsnip was present in 2015 than in 2014. The chemical control of Japanese knotweed on the stabilized slope and the wetland buffer along the former access road was planned for early October 2014, but could not be undertaken due to the apparent die off of the plants. Instead, the chemical control of knotweed occurred on the stabilized slope on August 31, 2015. No Japanese knotweed was seen in the restored wetland. No control of reed canary grass was undertaken; the non-native species was documented in the restored wetland in both 2013 and 2014, but none was seen within the plots in 2015 and it appears to have experienced a population decrease in the entirety of the restored roadway. We will continue to monitor reed canary grass abundance in subsequent sampling years. Preliminary results are indicating that the invasive grass is not going to become even a common species at the site, however the underground parts likely still persist and given appropriate coincidence of hydrologic conditions and changing competitiveness of other occurring species, it is possible for reed canary grass to proliferate.

Site Stability and Erosion Control

We have seen no changes in the restored wetland's performance of the previously documented functions of water storage, surface and groundwater protection and erosion control. From a wetland functions perspective, the restoration has been successful within the three-year time period to date. Differences pre- and post-project in these functions are minor and are attributed to the microtopography of the wetland

being altered and the presence of angular stone in scattered parts of the surface horizon.

Wetland Hydrology

Alterations due to compaction and soil mounding were estimated in 2013 to be less than 5% of the project area. In 2014 and again in 2015 these alterations were still evident but were largely hidden beneath the dense herbaceous vegetation and did not appear to be substantially detrimental to documented pre-disturbance wetland functions. Small areas of bare muck and open, standing water at the northern end of the roadway continue to exist; they are such a small percentage of the entire restoration site that they do not negatively impact erosion-control or surface and groundwater protection functions. These small disruptions from the season of truck traffic do not significantly change water storage capacity, but overall the site has slightly less water storage capacity than prior to construction, since the toe-slope stabilization included build-up of a berm adjacent to the river at the end of the restoration area.

General Assessment of Wetland Function

As expected, we continue to see that wildlife habitat functionality is altered from the natural condition due to a shift from a forest-dominated wetland to herbaceous vegetation. It is hoped that this cover change is temporary and we expect that tree and shrub cover will re-establish over a longer time frame (such as, 1-2 decades), and thus the wildlife habitat functionality would improve. Silver maple seedlings were common in scattered parts of the restoration, and vegetative sprouts of other trees continue to grow in and alongside the area. Woody plant regeneration is still quite sparse, however.

Background

The Bear Creek Environmental, LLC Biological Services Team was retained by the Vermont Agency of Transportation to prepare an Invasive Species Management, Planting and Monitoring Plan for the Maidstone STP 0271(20) project. The Plan includes measures to reduce impacts to wetlands, to prevent the proliferation of

invasive species, to restore wetland disturbed by the construction of a temporary access road, and to monitor the restored wetland. The following report provides a summary of the third year of monitoring after the construction of the temporary access road and subsequent restoration of the wetland. Monitoring of the restored wetland is a condition of the Army Corps of Engineers' Permit NAE-2011-0346 dated December 17, 2012.

The Maidstone STP 0271(20) project included the construction of a temporary road to allow construction access to repair a large slope failure on a cutbank of the Connecticut River that was threatening Route 102 in the town of Maidstone, Vermont (Figure 1). The temporary access road (Figure 2) was constructed during May 2013 and in part followed the pathway of an existing woods road that was located between VT Route 102 and the Connecticut River. The former access road was approximately 20 feet wide and included a disturbance width of between 30 and 40 feet. Following construction, the wetland was restored by removing the geotextile and road gravels down to the original grades. The site was seeded with wetland native seed mix in wetland areas and upland native seed mix in non-wetland areas adjacent to the wetland and then mulched. Straw mulch was applied to avoid the introduction of weeds and invasive species. Per the Maidstone Plan, the seeds for two uncommon species were harvested and stored for planting following construction. These uncommon species include Wiegand's wild-rye (*Elymus wiegandii*) and rough avens (*Geum laciniatum*). Marc Lapin, Ecologist with Ecosystem Conservation Science, sowed the seeds on June 23, 2013. The stabilized construction entrance was removed and planted with native trees and shrubs. The silt fence, located adjacent to the oxbow, was taken out during fall 2013 to allow flooding of the restored wetland. During the 2013 fall dormancy period, live dogwood and willow stakes were installed in the riprap in the wetland buffer.

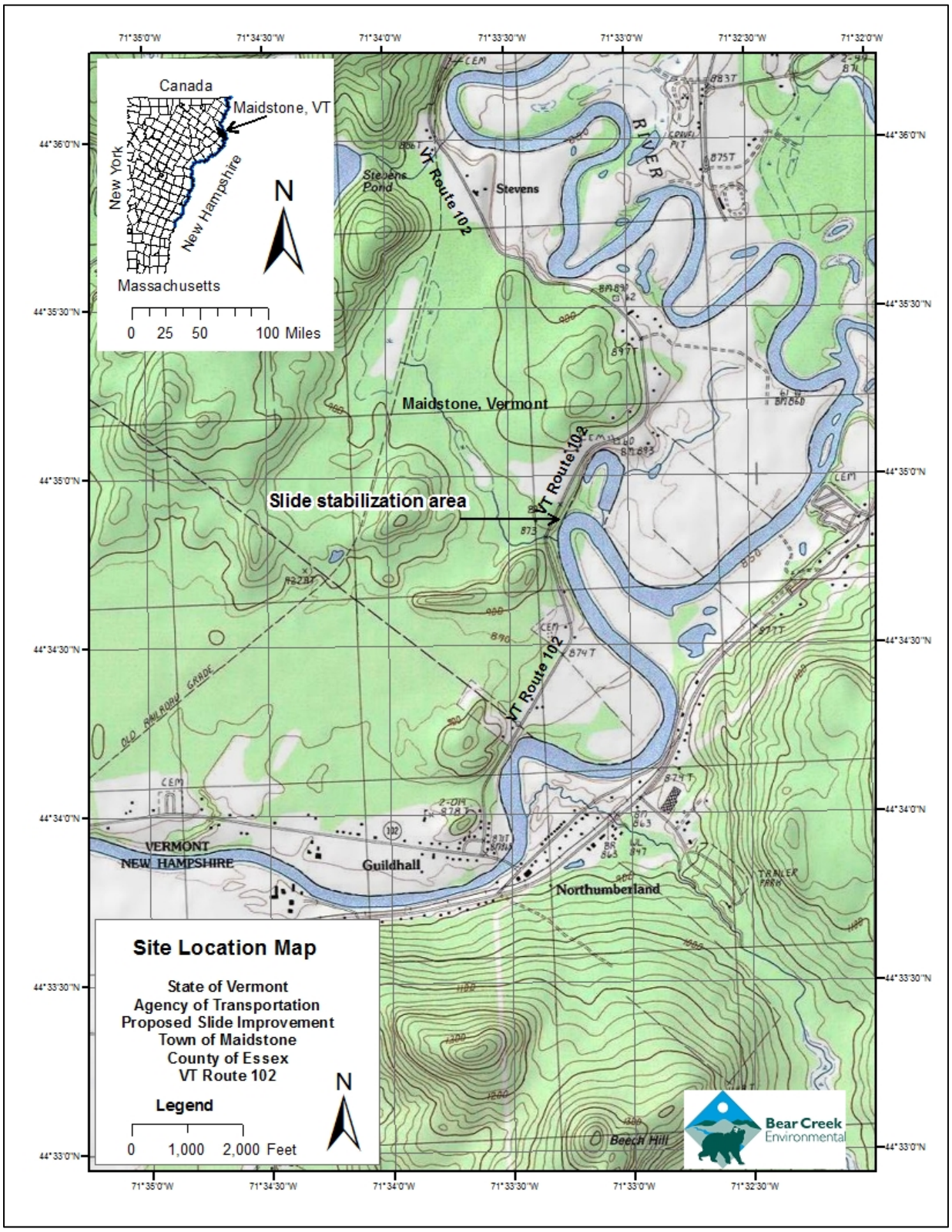

Figure 1. Site Location Map for Maidstone STP 0271(20) Project.

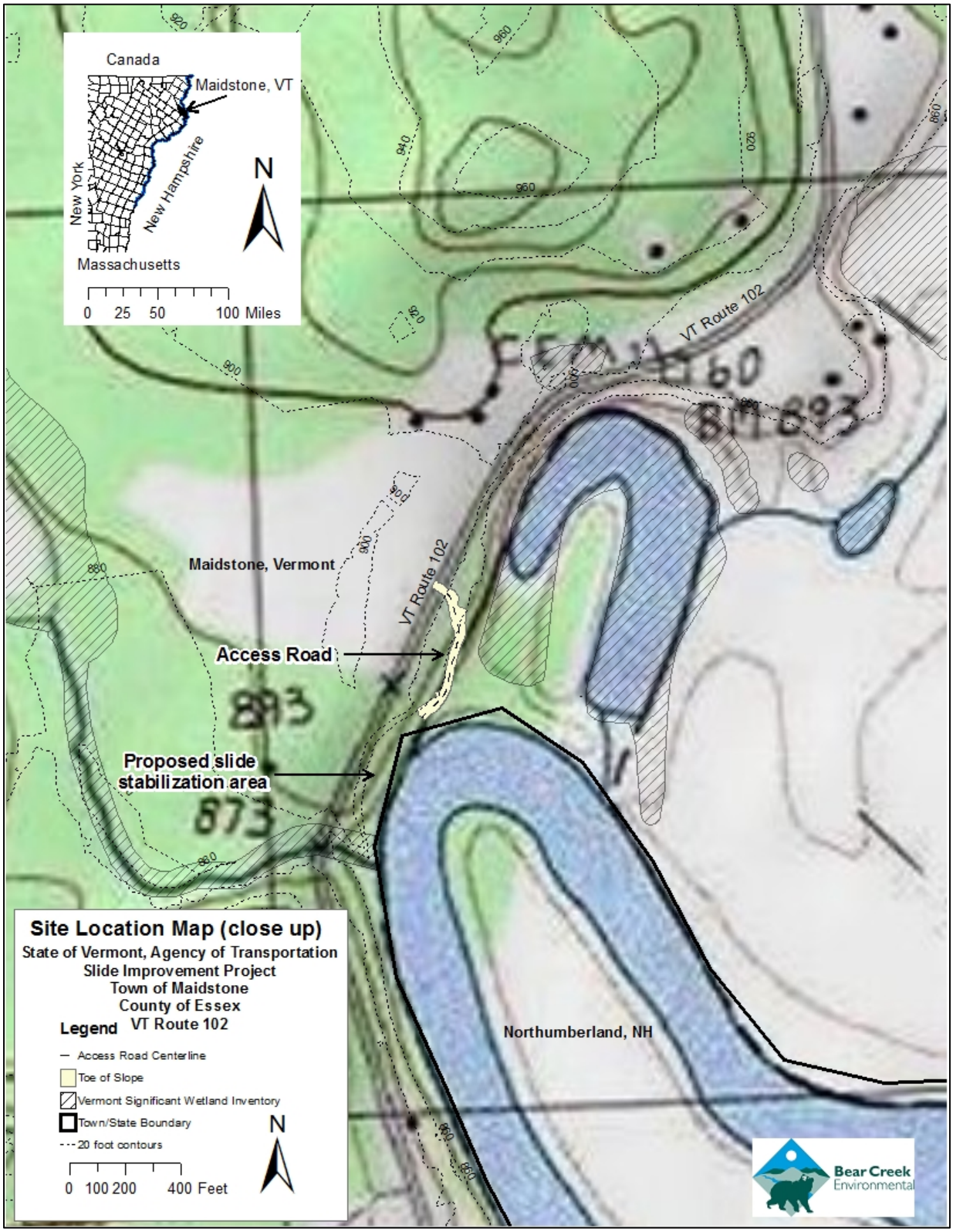

Figure 2. Location of Former Temporary Access Road.

Marc Lapin of Ecosystem Conservation Science and Mary Nealon of Bear Creek Environmental, LLC visited the Maidstone site on August 21, 2015 to conduct the third year of monitoring. First-year monitoring had been conducted on September 27, 2013 and is summarized in Lapin and Nealon (2013).[2] Second-year monitoring occurred on August 19, 2014; Lapin and Nealon (2014)[3] reports those results. The accepted plan calls for the site to be monitored for five years during the growing season, beginning the first growing season following the completion of the restoration activities. There are five general monitoring objectives:

1. Evaluation of the overall vegetative success in the wetland noting relative abundance of hydrophytic plant species within the restored wetland areas with a goal of 80 percent vegetative cover by native (non-invasive) species
2. Assessment of the presence/absence of invasive species within the restored wetland areas
3. General assessment of site stability and erosion control of wetland and adjacent area
4. General assessment of the presence of hydric soils and corresponding wetland hydrology
5. General assessment of wetland function

Methods

To quantitatively evaluate plant species composition two 5 x 5 m plots were established within the restored wetland area where the access road had been removed. Each permanent observation point was marked with a temporary stake and surveyed with a Mobile Mapper 100, GPS unit, capable of sub-meter accuracy. Documentation at the observation points included the identification of all vascular plant species present and a

[2] Lapin, M, and M. Nealon, 2013. Maidstone Slide – STP 0271(20) Year 1 Report: Wetland and Invasive Species Monitoring and Control Recommendations. Bear Creek Environmental Biological Services Team, Montpelier, VT.

[3] Lapin, M, and M. Nealon, 2014. Maidstone Slide – STP 0271(20) Year 2 Report: Wetland and Invasive Species Monitoring and Control Recommendations. Bear Creek Environmental Biological Services Team, Montpelier, VT.

corresponding estimate of percent cover. An overall approximation of percent cover of invasive species on the site was made.

Presence/absence of the three recognized wetland indicators (i.e., dominance by hydrophytic vegetation, presence of hydric soils, and indication of wetland hydrology) were assessed within the restored wetland areas. Wetland function was evaluated using the U.S. Army Corps of Engineers New England District Highway Methodology Workbook (USACE 1999) as a general guide.

Re-Vegetation of the Restored Access Road

Successful revegetation of the restored roadway has continued through three growing seasons. Native plant establishment was very good after one growing season following removal of the road, and has continued for the two subsequent years, although, as would be expected, there have been changes in both species composition and plant abundances. At the end of the first growing season over 85% of the area had plant cover, with 0% cover of invasive exotic shrubs. By late summer of the second growing season, plant cover was nearly 100%; the same near 100% cover was measured in 2015. The wet channels that had been bare in the previous two years were still not fully vegetated in 2015; these areas did, however, seem to have stable soil with no evident erosion and hosted plants able to establish and survive in shallow water.

The initial visual impression of the restoration revegetation of the wetter, northern section is one of tall blue vervain (*Verbena hastata*) and spotted touch-me-not (*Impatiens capensis*) above a lush sedges growth, with common arrowhead (*Sagittaria latifolia*) dominating the lowest wet spots. The drier restored area has half with dense smooth goldenrod (*Solidago gigantea*) intertwined with ribbons of Virginia virgin's-bower (*Clematis virginiana*) and the other half dominated by with purple-stemmed American-aster (*Symphyotrichum puniceum*) and eastern riverbank wild-rye (*Elymus riparius*). Beneath both of these sets of taller herbs are many small wetland graminoids and forbs.

Once again several invasive exotic shrubs were observed near the upland edge of the restored roadway; these few individuals were flagged for chemical control. One glossy buckthorn (*Rhamnus frangula*) was observed adjacent to Plot 1; this was the first indication of potential regeneration by seed of the invasive shrubs abundant in the adjacent upland slopes and flats. As in Year 2, there was a population of wild parsnip (*Pastinaca sativa*) in the mid-section of the restoration area, but there were many fewer plants than the dozen seen in Year 2. In Year 1 the non-native herbaceous plants creeping yellow-loosestrife (*Lysimachia nummularia*) and brittle-stemmed hemp-nettle (*Galeopsis tetrahit*)[4] comprised 20 to 30% of the plant cover in some parts of the restored roadway; by Year 2 these populations had diminished and in no parts of the restoration zone comprised more than several percent coverage. Plot sampling in Year 3 showed these two species to be about stable at the 2014 cover-abundance levels; moneywort did show a slight increase to 1% in the wetter area of the restoration and a slight decrease in the drier part. These exotic herbs are not listed as invasive species or noxious weeds in Vermont[5] or New Hampshire, although creeping yellow-loosestrife is on the New Hampshire Invasive Species Committee's watch list.[6] Except for moneywort in the wettest area and climbing nightshade (*Solanum dulcamara*) in the drier zone, all non-native species had less coverage than in previous years. In total six non-native species were present in the restoration area in Year 3 and eight additional non-native species had been recorded in either or both of the first two years but not in the most recent sampling. The small reed canary grass (*Phalaris arundinacea*) population that established in Year 1 has apparently decreased; none of that invasive exotic grass was documented in 2015. It will be interesting to see if stems are evident in Year 4, for underground parts may well have persisted, and despite a "non-vigorous" 2015 season the robust grass may return, in unknown abundance, next year.

[4] mis-identified as wild basil (*Clinipodium vulgare*) in 2013
[5] http://www.vtinvasives.org/plants/plant-quarantine-rule
[6] http://agriculture.nh.gov/divisions/plant_industry/documents/ invasive-watch-list.pdf; http://www.gencourt.state.nh.us/rules/state_agencies/agr3800.html

The two 5 x 5 m plots (Figure 3) that were established to document vegetation and soils in a very wet portion of the restored roadway (Table 1) and a dry portion of the restored roadway (Table 2) are useful for describing both the species composition in the different moisture zones of the restoration area and the changes that have occurred in three years of growth. The wet-site plot seems to have undergone a shift in species composition. The strong dominants of Year 2, Pylae's soft rush (*Juncus pylaei*) and common fox sedge (*Carex vulpinoidea*) had both decreased to only occasional abundance. Common arrowhead coverage more than doubled since Year 2; it is thriving in the shallow water conditions of the ruts that remain in this wettest portion of the restoration area. Additional species that increased in the third year include both tall, robust herbs and smaller plants. Four of the species that showed increases were included in the restoration seed mixes—blue vervain, boneset thoroughwort (*Eupatorium perfoliatum*), common evening-primrose (*Oenothera biennis*) and sensitive fern (*Onoclea sensibilis*). Silver maple (*Acer saccharinum*) seedling numbers increased, but there is no assurance or confidence that the first-year regeneration will survive, for mortality among maple seedlings is characteristically very high. We believe that species are "sorting out" based on successional and disturbance dynamics of the vegetation in combination with micro-level hydrology. The majority of species showed decreased cover-abundance over the three years and many were no longer present by Year 3. Five species (all natives) not previously recorded in the wet-site plot were present (rare to uncommon abundance levels) the third year. As in previous years, the wet plot had slightly lower species diversity than the drier plot; the third-year sampling showed a decrease to 33 species, from the 38 in Year 2 and the 35 in Year 1.

The drier plot, Plot 2, saw fewer pronounced changes. Continued dominance by smooth goldenrod and eastern riverbank wild-rye was recorded. Other strong performers were common soft rush (*Juncus effusus*) and path rush (*Juncus tenuis*), the latter a newer arrival and present only in one corner of the plot. Those species that diminished include red fescue (*Festuca rubra*), nodding beggar-ticks (*Bidens cernua*),

foxtail barley (*Hordeum jubatum*), water-pepper smartweed (*Persicaria hydropiper*), lady's-thumb smartweed (*P. maculosa*), foxtail grass (*Setaria* sp.) and cut grasses (*Leersia oryzoides*, *L. virginica*). These species are mostly ones that thrive as colonizers of bare ground and are no longer finding germination conditions suitable; others are perhaps simply being shaded out by taller vegetation or being "thatched over." Shrub cover did not increase in the drier zone from Year 2 to 3. Black elderberry, which had increased the previous year decreased from 5% back to 1% cover; perhaps branch-breakage in this weak-stemmed shrub was high in the winter or the spring floods. Thirty-seven species were in plot 2 in 2015, with 40 and 41 documented in the second and first year, respectively. Five native and no non-native species were newly recorded in the third-year dry-zone plot sample.

The woody plant dominants documented by Gustafson[7] in her wetland delineation are all present in the restoration except for highbush-cranberry (*Viburnum trilobum*). Of the two trees, black ash (*Fraxinus nigra*) and silver maple, only the maple has appeared as seed regeneration. Black ash has resprouted from stumps. Silver maple seedling numbers increased substantially in 2015. Nearly all of the tiny plants are in the northern, wetter part of the restoration where there is bare ground not covered by dense thatch of graminoids and/or goldenrods. Neither of those tree species occurs in the drier end of the restoration where the robust herbs are very dense. However, choke cherry (*Prunus virginiana*) and black elderberry (*Sambucus canadensis*) are both present (1% cover each) in the drier plot. Both species decreased in coverage in the third year, likely a result of having been matted down by winter snows or spring floods and overgrown by tall herbs. Based on these early indications, we expect that woody plant coverage will show a trend of slow increase in the restoration, with likely fluctuation and some years showing slight declines. Establishment and recruitment of the tree dominants is expected to be very slow, on the order of decades before even an open canopy establishes.

[7] Gustafson, S. 2011. Memo to John Lepore, VT Agency of Transportation. Re: Maidstone Slide Wetlands Evaluation, December 31, 2011. Shelley Gustafson Environmental, Ferrisburgh, VT.

In the entirety of the restored wetland area, we observed 97 species over three years of monitoring, a gain of one species from the second year (Table 4). Fifty-three species were recorded in the two plots, as compared with 64 species in the Year 2 plot sampling. Sixteen non-native species are included within the three-year total of 97 total species, but only six of those were present by Year 3. All species recorded by Gustafson in her pre-construction wetland delineation documentation of dominant species were present in the restoration area. None of those species were dominant after the third growing season of the restoration, but one would not expect such a rapid recovery to natural composition or structure of the vegetation after a disturbance as disruptive as construction of a temporary roadway.

Photo documentation of the vegetation is included as Appendix 1.

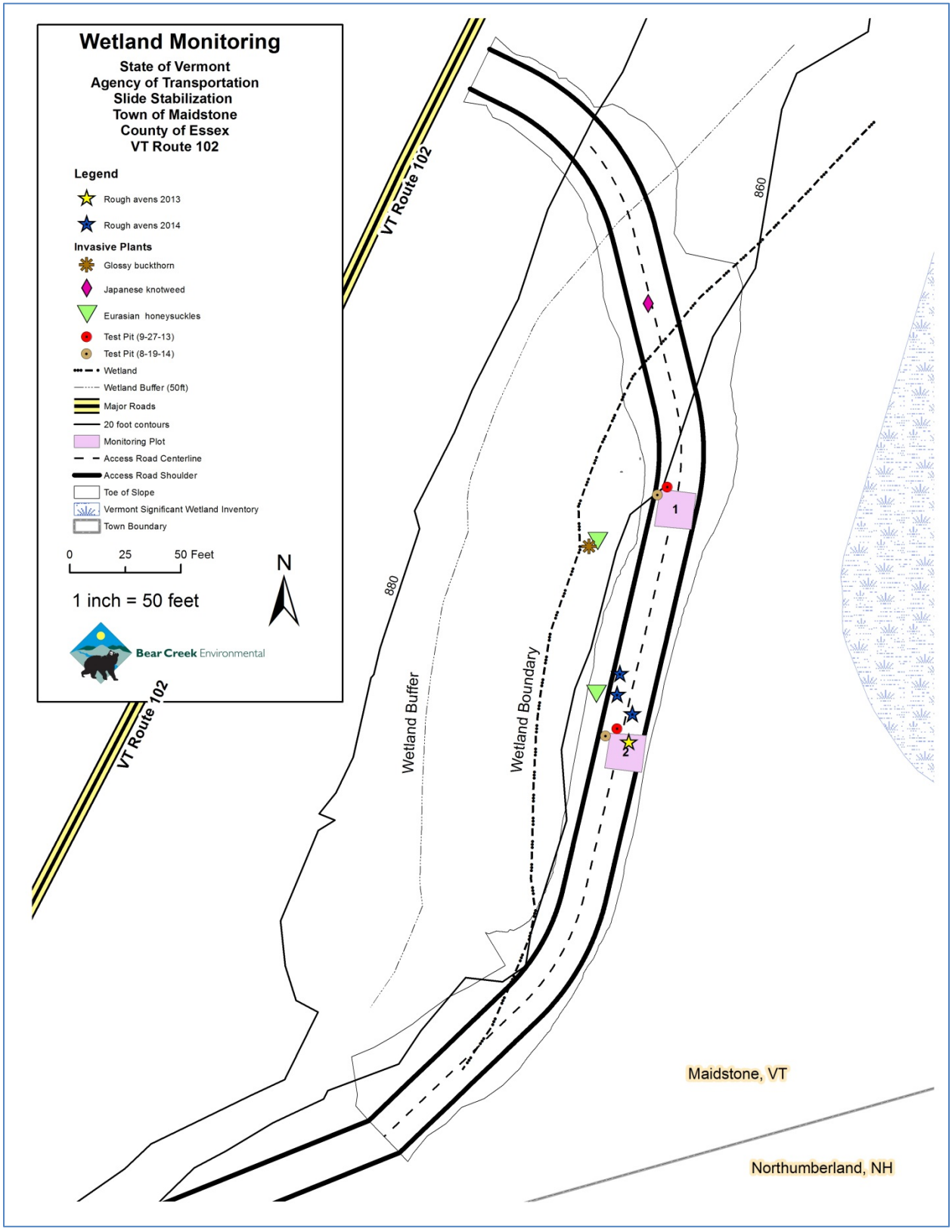

Figure 3. Wetland Restoration Monitoring Plots (sampled 9/27/13, 8/19/14, 8/21/15).

Table 1.
Plant Cover in Plot 1 (wettest area of restored roadway) for first three years of growth after restoration. Bold denotes species included in wetland seed mix; underline denotes included in upland seed mix.

Scientific Name	Common Name	2015 Cover or Abundance if <1% cover	2014 Cover or Abundance if <1% cover	2013 Cover or Abundance if <1% cover	Non-Native
Sagittaria latifolia	Common Arrowhead	35%	15%	r	
Epilobium ciliatum	Fringed Willow-Herb	5%	r	o	
Verbena hastata	Blue Vervain	5%	o		
Galium asprellum	Rough Bedstraw	2%	u	r	
Eupatorium perfoliatum	Boneset Thoroughwort	1%	r		
Impatiens capensis	Spotted Touch-Me-Not	1%	o	u	
Leersia oryzoides	Rice Cut Grass	1%	r		
Lysimachia nummularia	Creeping Yellow-Loosestrife	1%	o	o	*
Penthorum sedoides	Ditch-Stonecrop	1%	u		
Persicaria sagittata	Arrow-Leaved Tearthumb	1%	o	c	
Acer saccharinum	Silver Maple	c	r	r	
Carex scoparia	Pointed Broom Sedge	o	o		
Carex vulpinoidea	Common Fox Sedge	o	60%		
Juncus pylaei‡	Pylae's Soft Rush	o	65%	60%	
Solidago rugosa	Common Wrinkle-Leaved	o	r	r	
Athyrium filix-femina	Northern Lady Fern	u		o	
Galeopsis tetrahit	Brittle-Stemmed Hemp-Nettle	u	r	1%	*

Abundance ranking used if cover <1%

c=common, >10 plants, usually scattered widely through plot

o=occasional, 6-10 plants

u=uncommon, 3-5 plants

r=rare, 1-2 plants

NOTE: Percentages may total >100% due to layering of vegetation.

Bold denotes species included in wetland seed mix; underline denotes species included in upland seed mix.

‡ Assumed to be *J. effusus* in Year 1; determined to be *J. pylaei* in Year 2; advertised as *J. effusus* in seed mix; both are native species and both have been verified in the restored vegetation.

Scientific Name	Common Name	2015 Cover or Abundance if <1% cover	2014 Cover or Abundance if <1% cover	2013 Cover or Abundance if <1% cover	Non-Native
Galium palustre	Marsh Bedstraw	u	r	r	
Oenothera biennis	Common Evening-Primrose	u	r		
Onoclea sensibilis	Sensitive Fern	u	r	r	
Poa sp.	Bluegrass	u			
Scutellaria lateriflora	Mad Dog Skullcap	u			
Solidago gigantea	Smooth Goldenrod	u	r	o	
Agrimonia gryposepala	Common Agrimony	r			
Alisma triviale	Northern Water-Plantain	r	o	2%	
Bromus ciliatus	Fringed Brome	r	u		
Carex lurida	Sallow Sedge	r	o	1%	
Eutrochium maculatum	Spotted Joe-Pye Weed	r	u		
Iris versicolor	Blue Iris	r			
Lycopus uniflorus	Northern Water-Horehound	r			
Scirpus cyperinus	Common Woolsedge	r	o	r	
Sonchus sp.	Sow-Thistle	r			
Symphyotrichum puniceum	Purple-Stemmed American-Aster	r	r	r	
Mimulus ringens	Allegheny Monkey-Flower		o		
Scirpus atrovirens	Dark-Green Bulrush		o		
Scutellaria galericulata	Hooded Skullcap		u		
Typha latifolia	Broad-Leaved Cat-Tail		u	r	
Amphicarpaea bracteata	American Hog-Peanut		r		
Calamagrostis canadensis	Canada Reed Grass		r	o	

Abundance ranking used if cover <1%

c=common, >10 plants, usually scattered widely through plot

o=occasional, 6-10 plants

u=uncommon, 3-5 plants

r=rare, 1-2 plants

NOTE: Percentages may total >100% due to layering of vegetation.

Bold denotes species included in wetland seed mix; underline denotes species included in upland seed mix.

‡ Assumed to be *J. effusus* in Year 1; determined to be *J. pylaei* in Year 2; advertised as *J. effusus* in seed mix; both are native species and both have been verified in the restored vegetation.

Scientific Name	Common Name	2015 Cover or Abundance if <1% cover	2014 Cover or Abundance if <1% cover	2013 Cover or Abundance if <1% cover	Non-Native
Dichanthelium clandestinum	Deer-Tongue Rosette-Panicgrass		r		
Dulichium arundinaceum	Three-Way Sedge		r		
Glyceria grandis	American Manna Grass		r		
Osmundastrum cinnamomeum	Cinnamon Fern		r	r	
Phalaris arundinacea	Reed Canary Grass		r		*
Potentilla norvegica	Norwegian cinquefoil		r		
Bidens cernua	Nodding Beggar-Ticks			2%	
Echinochloa crus-galli	Common Barnyard Grass			u	*
Antennaria sp.	Pussy-toes			r	
Boehmeria cylindrica	Small-Spiked False Nettle			r	
Brassicaceae	Mustard			r	*
Clematis virginiana	Virginia Virgin's-Bower			r	
Eleocharis sp.	Spike-rush			r	
Fragaria virginiana	Common Strawberry			r	
Geum laciniatum	Rough Avens			single plant	
Juncus cf. brevicaudatus	Short-tailed Rush			r	
Persicaria arifolia	Halberd-Leaved Smartweed			r	
Rubus allegheniensis	Common Blackberry			r	
Rubus idaeus	Red Raspberry			r	
Rumex crispus	Curly Dock			r	*

Abundance ranking used if cover <1%

c=common, >10 plants, usually scattered widely through plot

o=occasional, 6-10 plants

u=uncommon, 3-5 plants

r=rare, 1-2 plants

NOTE: Percentages may total >100% due to layering of vegetation.

Bold denotes species included in wetland seed mix; underline denotes species included in upland seed mix.

‡ Assumed to be *J. effusus* in Year 1; determined to be *J. pylaei* in Year 2; advertised as *J. effusus* in seed mix; both are native species and both have been verified in the restored vegetation.

Table 2.
Plant Cover in Plot 2 (dry area in restored roadway) for first three years of growth after restoration. Bold denotes species included in wetland seed mix; underline denotes included in upland seed mix.

Scientific Name	Common Name	2015 Cover or Abundance if >1% cover	2014 Cover or Abundance if >1% cover	2013 Cover or Abundance if >1% cover	Non-Native
Solidago gigantea	Smooth Goldenrod	60%	40%	20%	
Juncus tenuis	Path Rush	20%			
Elymus riparius	Eastern Riverbank Wild-Rye	15%	25%		
Juncus effusus ‡	Common Soft Rush	10%			
Symphyotrichum puniceum	Purple-Stemmed American-	5%	r		
Arctium lappa	Great Burdock	2%	10%	1%	*
Athyrium filix-femina	Northern Lady Fern	2%	2%	1%	
Boehmeria cylindrica	Small-Spiked False Nettle	2%	o	r	
Galeopsis tetrahit	Brittle-Stemmed Hemp-Nettle	2%		20%	*
Clematis virginiana	Virginia Virgin's-Bower	1%	c	1%	
Impatiens capensis	Spotted Touch-Me-Not	1%	o	1%	
Prunus virginiana	Choke Cherry	1%	2%	1%	
Sambucus nigra	Black Elderberry	1%	5%	1%	
Solanum dulcamara	Climbing Nightshade	c	r	u	*
Agrimonia gryposepala	Common Agrimony	o	u	o	
Onoclea sensibilis	Sensitive Fern	o	r	u	
Lysimachia nummularia	Creeping Yellow-Loosestrife	u	o	10%	*

Abundance ranking used if cover <1%

c=common, >10 plants, usually scattered widely through plot

o=occasional, 6-10 plants

u=uncommon, 3-5 plants

r=rare, 1-2 plants

NOTE: Percentages may total >100% due to layering of vegetation.

Bold denotes species included in wetland seed mix; underline denotes species included in upland seed mix.

‡ Assumed to be *J. effusus* in Year 1; determined to be *J. pylaei* in Year 2; advertised as *J. effusus* in seed mix; both are native species and both have been verified in the restored vegetation.

Scientific Name	Common Name	2015 Cover or Abundance if >1% cover	2014 Cover or Abundance if >1% cover	2013 Cover or Abundance if >1% cover	Non-Native
Solidago rugosa	Common Wrinkle-Leaved	u	u		
Verbena hastata	Blue Vervain	u	u		
Carex lupulina	Hop Sedge	r			
Chelone glabra	White Turtlehead	r	r		
Dichanthelium clandestinum	Deer-Tongue Rosette-	r	r		
Dryopteris cristata	Crested Wood Fern	r	r		
Equisetum hyemale	Tall Scouring-Rush	r	u	o	
Eutrochium maculatum	Spotted Joe-Pye Weed	r		r	
Galium asprellum	Rough Bedstraw	r		r	
Galium palustre	Marsh Bedstraw	r	r	r	
Galium triflorum	Fragrant Bedstraw	r			
Geum laciniatum	Rough Avens	r	r	single plant	
Matteuccia struthiopteris	Ostrich Fern	r	r	r	
Oxalis stricta	Common Yellow Wood Sorrel	r	u	c	*
Persicaria sagittata	Arrow-Leaved Tearthumb	r			
Rubus hispidus	Bristly Blackberry	r	r		
Rumex crispus	Curly Dock	r		r	*
Solidago flexicaulis	Zigzag Goldenrod	r			
Symphyotrichum lateriflorum	Calico American-Aster	r	r	r	
Thalictrum pubescens	Tall Meadow-Rue	r	o	r	
Festuca rubra	Red Fescue		60%	60%	

Abundance ranking used if cover <1%

c=common, >10 plants, usually scattered widely through plot

o=occasional, 6-10 plants

u=uncommon, 3-5 plants

r=rare, 1-2 plants

NOTE: Percentages may total >100% due to layering of vegetation.

Bold denotes species included in wetland seed mix; underline denotes species included in upland seed mix.

‡ Assumed to be *J. effusus* in Year 1; determined to be *J. pylaei* in Year 2; advertised as *J. effusus* in seed mix; both are native species and both have been verified in the restored vegetation.

Scientific Name	Common Name	2015 Cover or Abundance if >1% cover	2014 Cover or Abundance if >1% cover	2013 Cover or Abundance if >1% cover	Non-Native
Scutellaria lateriflora	Mad Dog Skullcap		o		
Leersia oryzoides	Rice Cut Grass		u	15%	
Phalaris arundinacea	Reed Canary Grass		u	1%	*
Arisaema triphyllum	Jack-In-The-Pulpit		r		
Bromus ciliatus	Fringed Brome		r		
Epilobium ciliatum	Fringed Willow-Herb		r	r	
Eupatorium perfoliatum	Boneset Thoroughwort		r		
Eurybia divaricata	White Wood-Aster		r		
Leersia virginica	White Cut Grass		r		
Muhlenbergia cf. frondosa	Wire-Stemmed Muhly		r		
Pastinaca sativa	Wild Parsnip		r	r	*
Rhus typhina	Staghorn Sumac		r		
Calamagrostis canadensis	Canada Reed Grass			5%	
Setaria sp.	Foxtail Grass			2%	*
Bidens cernua	Nodding Beggar-Ticks			1%	
Hordeum jubatum	Foxtail Barley			1%	
Dryopteris carthusiana	Spinulose Wood Fern			c	
Plantago cf. major	Common Plantain			c	*
Agrostis gigantea	Redtop Bentgrass			o	
Amphicarpaea bracteata	American Hog-Peanut			r	
Carex cf. lacustris	Lakeside Sedge			r	

Abundance ranking used if cover <1%

c=common, >10 plants, usually scattered widely through plot

o=occasional, 6-10 plants

u=uncommon, 3-5 plants

r=rare, 1-2 plants

NOTE: Percentages may total >100% due to layering of vegetation.

Bold denotes species included in wetland seed mix; underline denotes species included in upland seed mix.

‡ Assumed to be *J. effusus* in Year 1; determined to be *J. pylaei* in Year 2; advertised as *J. effusus* in seed mix; both are native species and both have been verified in the restored vegetation.

Scientific Name	Common Name	2015 Cover or Abundance if >1% cover	2014 Cover or Abundance if >1% cover	2013 Cover or Abundance if >1% cover	Non-Native
Persicaria hydropiper	Water-Pepper Smartweed			r	
Persicaria maculosa	Lady's-Thumb Smartweed			r	*
Solanum nigrum	European Black Nightshade			r	*
Symphyotrichum cordifolium	Heart-Leaved American-Aster			r	
Asclepias incarnata	Swamp Milkweed				
Juglans cinerea	Butternut				
Oenothera biennis	Common Evening-Primrose				

Abundance ranking used if cover <1%

c=common, >10 plants, usually scattered widely through plot

o=occasional, 6-10 plants

u=uncommon, 3-5 plants

r=rare, 1-2 plants

NOTE: Percentages may total >100% due to layering of vegetation.

Bold denotes species included in wetland seed mix; underline denotes species included in upland seed mix.

‡ Assumed to be *J. effusus* in Year 1; determined to be *J. pylaei* in Year 2; advertised as *J. effusus* in seed mix; both are native species and both have been verified in the restored vegetation.

Table 3.
Plants in Restored Roadway Outside of Sample Plots, first three years.

Scientific Name	Common Name	Non-Native	2013	2014	2015
Agropyron sp.	Wheat Grass	*	x		
Alnus incana	Speckled Alder		x		x
Amphicarpaea bracteata	American Hog-Peanut				x
Arisaema triphyllum	Jack-In-The-Pulpit		x		
Asclepias incarnata	Swamp Milkweed			x	
Eurybia divaricata	White Wood-Aster		x		
Fraxinus americana	White Ash			x	x
Fraxinus nigra	Black Ash			x	x
Glyceria canadensis	Rattlesnake Manna Grass				x
Hylotelephium erythrostictum	Garden Stonecrop	*			x
Juglans cinerea	Butternut			x	x
Lycopus uniflora	Northern Water-Horehound			x	
Menispermum canadense	Canada Moonseed		x		
Mimulus ringens	Allegheny Monkey-Flower				x
Muhlenbergia cf. frondosa	Wire-Stemmed Muhly		x		x
Rhamnus frangula	Glossy Buckthorn	*			x
Rubus allegheniensis	Common Blackberry			x	x
Rumex crispus	Curly Dock	*		x	
Sium suave	Water-Parsnip			x	
Tussilago farfara	Coltsfoot	*		x	
Typha latifolia	Broad-Leaved Cat-Tail				x

Table 4.
Changes in Plant Species Richness in the first three years.

	Year 1	Year 2	Year 3
Total number of plant species observed all years	67	96	97
Number of plant species within both plots each year	61	64	53
Number of non-native plant species	16	7	6

Invasive Species Observations

Year 3 monitoring once again revealed that the invasive exotic shrubs common in the adjacent upland, glossy buckthorn (*Rhamnus frangula*) and Eurasian honeysuckles (*Lonicera tatarica*, and/or *L. morrowii*), had not seeded into the restoration area. We did however again find a few of these shrubs adjacent to the restoration (Figure 3) and

these were treated by a licensed pesticide applicator in early October 2014 and late August 2015 using a glyphosate-based herbicide.

Non-native species observed in the restored area but not considered “noxious weeds” by either Vermont or New Hampshire included creeping yellow-loosestrife (*Lysimachia nummularia*), reed canary grass (*Phalaris arundinacea*) and wild parsnip (*Pastinaca sativa*). No new non-native species were observed in Year 3, and in fact the number of non-native species has continued to decrease. Approximately half a dozen wild parsnip were hand-pulled, bagged in plastic, removed from the site, and disposed of in a landfill. The wild parsnip population was half or less of that seen in Year 2.

No reed canary grass was seen in either of the plots, but it certainly remains present within the restoration. No control of the invasive grass has been undertaken, and it appears to have experienced a population decrease in the entirety of the restored roadway. We will continue to monitor reed canary grass abundance in subsequent sampling years. Preliminary results are indicating that it is not going to become even a common species at the site, however the underground parts likely still persist and given appropriate coincidence of hydrologic conditions and changing competitiveness of other occurring species, it is possible for reed canary grass to proliferate.

The other “non-noxious” non-native herb common to wetlands, creeping yellow-loosestrife, increased slightly from occasional to 1% in the wetter area and continued its decrease from 10% to occasional to uncommon in the drier plot. There is less competition for light and space in the wetter area at present.

Invasive Species Recommended Control

After monitoring was completed we recommended chemical control of glossy buckthorn and Eurasian honeysuckles that were in the wetland adjacent to the restoration area and Japanese knotweed that was present along the stabilized slope and the wetland buffer of the former access road (Figure 3). Chemical treatment of glossy buckthorn and

Eurasian honeysuckles was completed by Vegetation Control Services on October 2, 2014 and August 31, 2015. The Japanese knotweed plants we observed on the stabilized slope and in the wetland buffer of the former access road on August 19, 2014 were not conspicuous on October 2, 2014, and therefore, could not be treated with the herbicide in 2014. Although Japanese knotweed was not observed within the restored wetland, control of the knotweed in outlying areas is vital for preventing the spread into the wetland. Control of wild parsnip in the restored wetland was conducted by hand-pulling by Mary Nealon on August 19, 2014 and August 21, 2015.

In the Invasive Species Management, Planting and Monitoring Plan dated December 13, 2012, we recommended five years of monitoring. Initial findings are favorable, but it is still prudent to conduct an additional two years of monitoring to determine if continued invasive species control is recommended in order to achieve the vegetative success goal of 80% cover by native non-invasive species. We expect that within the next two years the invasive shrubs and wild parsnip will be relatively easy to control. If reed canary grass is seen to expand and overtake native vegetation, adaptive management should be practiced and alternatives for controlling it should be evaluated and discussed.

Uncommon Species

The two uncommon species that were present prior to construction and restoration, rough avens (*Geum laciniatum*) and Wiegand's wild-rye (*Elymus wiegandii*), have fared very differently. Seeds of both species were collected in October 2012, and dispersed within the restoration area on June 23, 2013. Rough avens has established in the restored roadway, whereas Wiegand's wild-rye has not.

Year 3 monitoring continues to verify establishment and fruiting of rough avens within the drier portion of the restoration area (Figure 3). A few individuals continue to grow within plot 2, with more thriving nearby outside of the plot. The plants appear to be setting viable seed. We reiterate from previous observations that close to the river, where the bulk of the original population had been located, does not appear to be

suitable habitat, as it has been engineered with fill as a lower-slope area to help support the reconstructed slope and cannot be considered part of the wetland restoration. Nonetheless, judging from Year 2 and 3 observations of the population size, vigor and reproductive status of rough avens in the restoration area, the collection, storage and dispersal of the seeds of this uncommon species have apparently been successful since these conservation actions seem to have aided in the re-establishment of a population that would otherwise have been nearly or fully decimated in this part of the floodplain forest.

Wiegand's wild-rye tells the opposite story. The uncommon grass frequently occupies only a very narrow band (about 5 meters) close to the river, and since the restoration area does not actually extend fully to the river due to the engineering of the slope for stability, the preferred habitat has not been restored. Fortunately, the population atop the riverbank in the floodplain forest adjacent to the project area was not disturbed and remains sizable and vigorous. The population appears to be stable in the undisturbed portion of the floodplain upstream of the construction zone.

Soils in the Restored Access Road Site

Since observations of soils pits that were dug adjacent to each plot in 2013 and 2014 showed soils were restored to hydric soils, we decided it would be better not to disturb another two meter-square pits to make further observations in 2015. Soil changes in the restored area will be on a time scale of decades to centuries; it is therefore not necessary to continue sampling each year of the initial five-year monitoring.

Site Stability

Once again this third year observations support our initial finding that wetland site stability has been well restored. Pre-construction, the site was fully forested and had no bare soil. At the end of Year 1 the site had at least 85% vegetation cover; 15% or less of the site was covered by either open water or straw mulch. Late in the growing

season of both Years 2 and 3 the site had over 90% vegetation cover; less than 5% of the site featured open water. No erosion was noted in either 1) the restored area, 2) the adjacent portion of floodplain forest that was disturbed by tree and shrub removal but was not part of the temporary access road, or 3) the engineered slope section that was a combination of wetland buffer and some floodplain forest (identified as "Area 4 – Riprap in Wetland Buffer" in the Planting Plan). The area where the only construction disturbance was tree and shrub removal continued to support re-sprouting trees and shrubs and dense herbaceous floodplain vegetation. The wetland buffer riprapped area continued to be well stabilized by the coir matting, herbaceous vegetation that established post-construction from the native seed mix, the shrub plantings, and volunteer "weeds" (including brittle-stemmed hemp-nettle, common agrimony and curly dock).

Wetland Functions

We see no reason to alter our Year 1 and 2 assessments stating that the wetland's previously documented functions have not been substantially altered. Three growing seasons post-restoration the functional capacities for water storage, surface and ground water protection, and erosion control are very close to the initial levels. Changes continue to be minor and related to 1) the structural changes to vegetation, and 2) the limited areas of soil compaction and mounding in the project area. Additionally, diminishment of wildlife habitat functionality was also minor and was related to changes in vegetation composition and structure. As stated above, since very few seedlings of trees were found in the restored area, we expect recovery to forest habitat to be relatively slow. The increase in cover of the shrub black elderberry and the sprouting of white and black ash stumps in the restoration area bode well for recovery within a decade to some woody vegetation, but not likely a closed-canopy young forest of saplings. Edge effects along the restored roadway continue to be of concern, especially in relation to the potential increase in density of invasive shrubs glossy buckthorn and Eurasian honeysuckles, if control measures are not continued when necessary.

APPENDIX 1.

Photographic Documentation

Figure 4. Vegetation of Plot 1 in third year of restoration. The prominent plants are common arrowhead (right) and blue vervain (left), with goldenrod in the background.

Figure 5. Vegetation of Plot 1 in third year of restoration. One of the wet, bare-soil portions showing silver maple first-year seedlings, with fringed willow-herb, moneywort, and graminoid thatch.

Figure 6. Vegetation of Plot 1 third year of restoration. One of the former tire ruts showing standing water and a large assortment of wetland graminoids and forbs.

Figure 7. Vegetation of Plot 2 third year of restoration. Eastern riverbank wild-rye and smooth goldenrod dominate about one-half of the plot.

Figure 8. Vegetation of Plot 2 in third year of restoration. Center of photo shows fruiting black elderberry, a common shrub in the drier part of the restored floodplain site.

Figure 9. Vegetation of plot 2 in third year, with undisturbed floodplain forest in background. Present are black elderberry, brittle-stemmed hemp-nettle (non-native), Virginia virgin's-bower, smooth goldenrod, spotted touch-me-not, rough bedstraw, wood-nettle and blue vervain.