

**Environmental  
Resources  
Management**

28 February 2008  
Reference: 0061882

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Mr. Brian Monahan, Conservation Administrator  
Wayland Conservation Commission  
Town Building  
Wayland, MA 01778



Re: Restoration Plan (DEP File# 322-553)  
Wetland Restoration Area  
Former Raytheon Facility  
430 Boston Post Road, Wayland, MA

Dear Mr. Monahan and Commissioners:

On behalf of Raytheon Company (Raytheon), Environmental Resources Management (ERM) submits this Restoration Plan (Plan) for adaptive management activities in the wetland restoration area at the above-referenced site.

This Plan is provided in accordance with Special Condition 69 of the Order of Conditions (OOC) dated 26 September 2003 and valid until 26 September 2008. The Plan details the adaptive management measures previously implemented and planned for the 2008 growing season. Prior to expiration of the OOC, a Certificate of Compliance will be sought since the goal of the project, the removal of contaminated soil and sediment, has been accomplished and the restoration area is functioning as a ecologically valuable wetland.

The focus of the adaptive management measures proposed in this Plan is the suppression of purple loosestrife (*Lythrum salicaria*) because it is the most dominant invasive species in the restoration area and best suited to thrive in this hydrologic setting. An evaluation of available control mechanisms indicates that mechanical control (i.e., hand pulling and cutting) is the most feasible option for control of purple loosestrife in the restoration area. Mechanical control of purple loosestrife is proposed through the 2008 growing season.

## **BACKGROUND**

In the fall of 2002 and early winter 2003, remediation activities were conducted under the Massachusetts Contingency Plan (MCP) to address

contaminated soil and sediment in an approximately two-acre wetland area at the Former Raytheon Facility, 430 Boston Post Road, Wayland, Massachusetts (the "Site"). The Wayland Conservation Commission issued an OOC for the excavation of impacted soils and restoration of the wetland. Under the OOC, Raytheon conducted annual monitoring of the wetland restoration area. Annual wetland monitoring reports were previously submitted to the Commission for the 2004 (Woodlot, 2004), 2005 (Woodlot, 2005), 2006 (ERM, 2006), and 2007 (ERM, 2007) growing seasons.

The 2007 Annual Wetland Restoration Monitoring Report (ERM, 2007) concluded that the restoration area is fully vegetated, stabilized, and providing a host of wetland functions such as wildlife habitat and flood and water quality protection for the Sudbury River. It is anticipated that the current emergent marsh will, over time, transition to a scrub-shrub wetland community to mimic the surrounding wetland areas outside the restoration area. In addition to the planted buttonbush stock, dense, mature buttonbush communities adjacent to the restoration area will also provide an ample source of seedlings to colonize the restoration area.

The 2007 Annual Wetland Restoration Monitoring Report also documented that the restoration area has not achieved the required percentage of vegetative cover established in the OOC due to the presence of non-native plant species. Special Condition 67 of the OOC identifies vegetative cover as the only success criteria for the functions and values of the restoration area. The condition requires:

- 90 percent or more areal coverage of wetland vegetation (designated FAC or wetter, and approved by the Commission) is re-established and survives for three or more years; and
- 100 percent survival of planted buttonbush (*Cephalanthus occidentalis*) for three consecutive growing seasons.

Special Condition 69 of the OOC requires that a formal restoration plan be submitted to the Commission if the restoration area is not meeting the success standards stated in Special Condition 67. The results of the 2007 wetland monitoring activities are summarized on Figure 1 - Invasive Species Mapping.

## **ADAPTIVE MANAGEMENT ACTIVITIES**

Several adaptive management measures were implemented during the first four growing seasons in order to facilitate compliance with the OOC, the Section 401 Water Quality Certification and the Section 404 Permit.

Specifically, the applicant has:

- Installed replacement buttonbush shrubs;
- Planted larger more vigorous plant stock; and
- Repeatedly undertaken mechanical control of invasive species by hand-pulling, cutting, and off-site disposal of both root masses (purple loosestrife) and inflorescences (loosestrife, barnyard grass) of invasive plant species.

Control of invasive plant species has been accomplished through mechanical cutting and removal of seed heads during the past two growing seasons. Three non-native, invasive plant species have been documented as present in the restoration area; purple loosestrife (*Lythrum salicaria*), barnyard grass (*Echinochloa crus-galli*) and a hybrid cattail (*Typha x glauca*).

The focus of the invasive species control activities to be continued in 2008 is to further suppress purple loosestrife (*Lythrum salicaria*). Purple loosestrife is the most aggressive of the three invasive species identified at the Site and is most successful under the hydrologic (seasonally flooded emergent marsh) and light conditions (full sun) observed at the Site. Two other non-native invasive species, barnyard grass and hybrid cattail, will continue to be suppressed under this Plan. However, these two species do not represent as significant an ecological threat as purple loosestrife. This assumption is supported by the following:

- Barnyard grass is an annual, non-wetland plant but is often an initial colonizer of disturbed settings. The significant reduction in percent cover of barnyard grass per plot between the 2006 and 2007 growing seasons (69.3% decrease) shows that this species can be controlled by cutting prior to seed set and through competition with the current dense cover of native wetland species. The long-term hydrology of the emergent marsh/floodplain is not suitable to this species.
- The hybrid cattail occurs over only a very minor percentage of the vegetative cover (0.7% cover per plot), and has not formed any monotypic stands in the restoration area. The cattails are interspersed with stands of hard stem bulrush (*Scirpus acutus*) and contribute to valuable emergent marsh wildlife habitat and water quality polishing. This species will be monitored and management measures employed as necessary to continue to suppress lateral expansion of this species.

Efforts to control invasive species through mechanical measures over the past two growing seasons have resulted in a reduction in total coverage of the invasive species established in the restoration area. However, these reductions have not been sufficient to attain the required 90% plant coverage by native species and the reduction can not be maintained without constant control of invasive species.

## **INVASIVE SPECIES MANAGEMENT**

In order to develop the Plan, ERM evaluated several options to further control invasive species and attempt to satisfy the success standards established in Special Condition #67. Table 1 describes potential management measures that may be utilized to suppress the non-native invasive species present in the restoration area (purple loosestrife, barnyard grass, and hybrid cattail). Presented in general categories of physical, chemical and biological controls, the overall effectiveness of these management measures is also described.

As stated previously, hybrid cattail and barnyard grass do not represent a significant ecological threat to the restoration area. The focus of the adaptive measures for 2008 is to suppress purple loosestrife because it is the most dominant invasive species and best suited to thrive in the Site setting. The subsequent sections describe available control mechanisms applicable to purple loosestrife.

### ***Mechanical Control of Purple Loosestrife***

Mechanical control of purple loosestrife was conducted at the site in 2006 and 2007. The effects of this control mechanism are immediately observable and cutting or hand pulling has been implemented on multiple occasions throughout the year with only minimal effect on surrounding native vegetation.

Hand-pulling is recommended for small populations and isolated stems. Ideally, the plants should be removed before they have set seed. Because the plants are capable of regenerating from root fragments, the entire rootstock must be removed. Better control results have been observed early in the season because the entire rootstock can more easily be removed from wetter, softer soils. Removal of individual plants may allow native wetland vegetation to compete more successfully.

Cutting of pre-dispersal seedheads is an effective method of reducing seed fall; however, because purple loosestrife also has some ability to

spread vegetatively, reduction in seed dispersal is not likely to provide long-term control beyond the period of active management.

Large, established populations of purple loosestrife exist within the Sudbury River floodplain. Such established populations are difficult to eradicate using mechanical measures. These populations can, through intensive and repeated hand-pulling of new plants around the periphery, be contained in place. Populations of three acres or less may be controllable by hand-pulling, depending on the size of the work crew and time available.

### *Chemical Control of Purple Loosestrife*

Rodeo™ (active ingredient - Glyphosate) is commonly used in wetlands throughout Massachusetts to safely and effectively control invasive plant species such as purple loosestrife. The chemical Glyphosate interferes with essential plant growth processes, causing gradual wilting, browning, overall deterioration of the plant, and, eventually, mortality. The resulting reduction in loosestrife density and vigor allows native plant species to recolonize and compete more successfully within the targeted area.

The use of herbicides for this project was initially envisioned as the primary means to control invasive plant species for this project. Section 7.5.2 of the Notice of Intent document, entitled "Single Environmental Impact Report and Notice of Intent for the Remediation of Oils and Hazardous Materials in Sudbury River Floodplain Wetlands" (ERM, 2003), stated that exotic and nuisance species controls will involve the use of selective herbicide treatments in wetland areas. The herbicide Rodeo™ was specifically mentioned for use, together with removing flowers or seed heads of invasive plants.

The Commission prohibited the use of herbicides for this project with Special Condition No. 58 of the OOC, thus, eliminating this control measure from consideration and curtailing the ability to meet the success standards established in the OOC. By comparison, the U.S. Army Corps of Engineers and DEP do not prohibit the use of herbicides in the Section 404/401 permits issued for this project.

### *Biological Control of Purple Loosestrife*

A potentially effective alternative method for suppressing the dominance of purple loosestrife is the use of biological controls. Two species of leaf-eating beetles, the black margined loosestrife beetle (*Galerucella*

*calmariensis*) and the golden loosestrife beetle (*Galerucella pusilla*) have been approved by the USDA Animal & Plant Health Inspection Service (APHIS) for purple loosestrife biocontrol projects and can be effective under the proper conditions.

Biocontrol of purple loosestrife in Massachusetts is an established and accelerating control technique. The Massachusetts Office of Coastal Zone Management (MACAM) Wetlands Restoration Program has established the state-wide "Purple Loosestrife Biocontrol Project", in cooperation with USDA-APHIS. Under this program, MACZM has undertaken or participated in the establishment of biocontrol insect populations at numerous locations statewide. In addition, the US Fish & Wildlife Service relies almost exclusively on biocontrol of purple loosestrife at the Great Meadows National Wildlife Refuge, abutting the Site, and has undertaken beetle releases on federal lands in the Sudbury River watershed since the late 1990's.

This biological control method is intended to develop long-term populations of specifically-adapted insect predators. The intent is to suppress the population of purple loosestrife in order to allow native species to colonize and eventually out-compete the purple loosestrife within the targeted wetland area. This biological control method will not eliminate purple loosestrife but will suppress the vigor of individual plants.

Establishment of insect populations adequate enough to affect biocontrol of loosestrife is generally anticipated to take from 3-5 years from the season of first introduction. Therefore, although biocontrol is a widely utilized and accepted method, it is unlikely that the effects of leaf-eating beetles in the restoration area would be observed over the next several growing seasons. It is also important to note that biological control of purple loosestrife is unlikely to eliminate or significantly reduce the percent cover of this species in the restoration area to allow for the vegetative success standards to be met.

## CONCLUSIONS

Despite achieving a total vegetative cover of 84% over the entire restoration area, as documented by 25 randomly-located vegetation sample plots, data from the 2007 Annual Monitoring Report (ERM, 2007) indicates that the vegetative success standards established in Special Condition 67 of the OOC have not been met. These deficiencies can largely be attributed to the continued dominance of purple loosestrife throughout the restoration area.

The results of the review of available control mechanisms as well as the 2007 monitoring results indicate the following:

- The restoration area is providing valuable wildlife habitat as emergent marsh as well as providing flood and water quality protection for the Sudbury River;
- The project was successful in restoring an approximately two-acre wetland area by removing contaminated sediment and soil and re-establishing the hydrology, topography, and the emergent marsh community;
- Large, established populations of purple loosestrife exist within the Sudbury River floodplain;
- Biological control of purple loosestrife through the release of leaf-eating beetles is unlikely to eliminate or significantly reduce the percent cover of this species in the restoration area to allow for the vegetative success standards to be met;
- Special Condition No. 58 of the OOC prohibits the use of herbicides to control invasive species in the restoration area;
- Mechanical control of purple loosestrife can be implemented several times per growing season with little to no effect on the surrounding native vegetation;
- Removal of individual plants through hand-pulling may allow native wetland vegetation to compete more successfully;
- Mechanical control of purple loosestrife is not likely to provide any long-term control beyond the period of active management; and
- Given the apparent size of the on-site purple loosestrife seedbank, and the seed deposited onto the restoration site by floodwaters each year from the surrounding purple loosestrife populations, the mechanical and biological means available to the applicant are not likely to control loosestrife adequately to meet the numerical standards for restoration success set forth in the Order of Conditions.

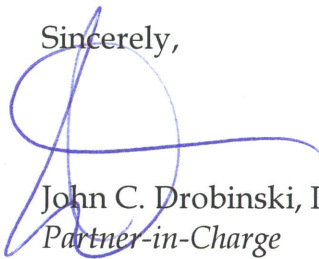
## **CONTINUED ADAPTIVE MANAGEMENT ACTIVITIES 2008**

Based on a review of available control mechanisms, mechanical control of purple loosestrife through continued cutting, hand-pulling and removing seed heads is proposed for the 2008 season. Chemical and/or biological control of invasive species are not feasible at the site.

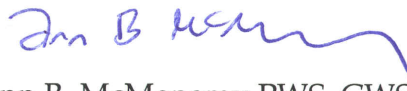
Raytheon will conduct invasive species control measures on at least three occasions throughout the 2008 growing season. Mechanical control of purple loosestrife will be implemented through hand-pulling of plants or cutting of pre-dispersal seed heads. Although hybrid cattail and barnyard grass are not the primary ecological threat at the Site, these species will also be targeted through mechanical control as part of the 2008 invasive species management activities. Purple loosestrife, hybrid cattail and barnyard grass will be cut throughout the restoration area, collected in plastic bags, and disposed of off-site.

If requested, Raytheon and ERM are available to discuss the activities proposed in this Plan. If you have any questions regarding the Restoration Plan, please contact either of the undersigned at 617-646-7800.

Sincerely,



John C. Drobinski, P.G., LSP  
*Partner-in-Charge*



Ann B. McMenemy PWS, CWS  
*Program Director Ecological Services*

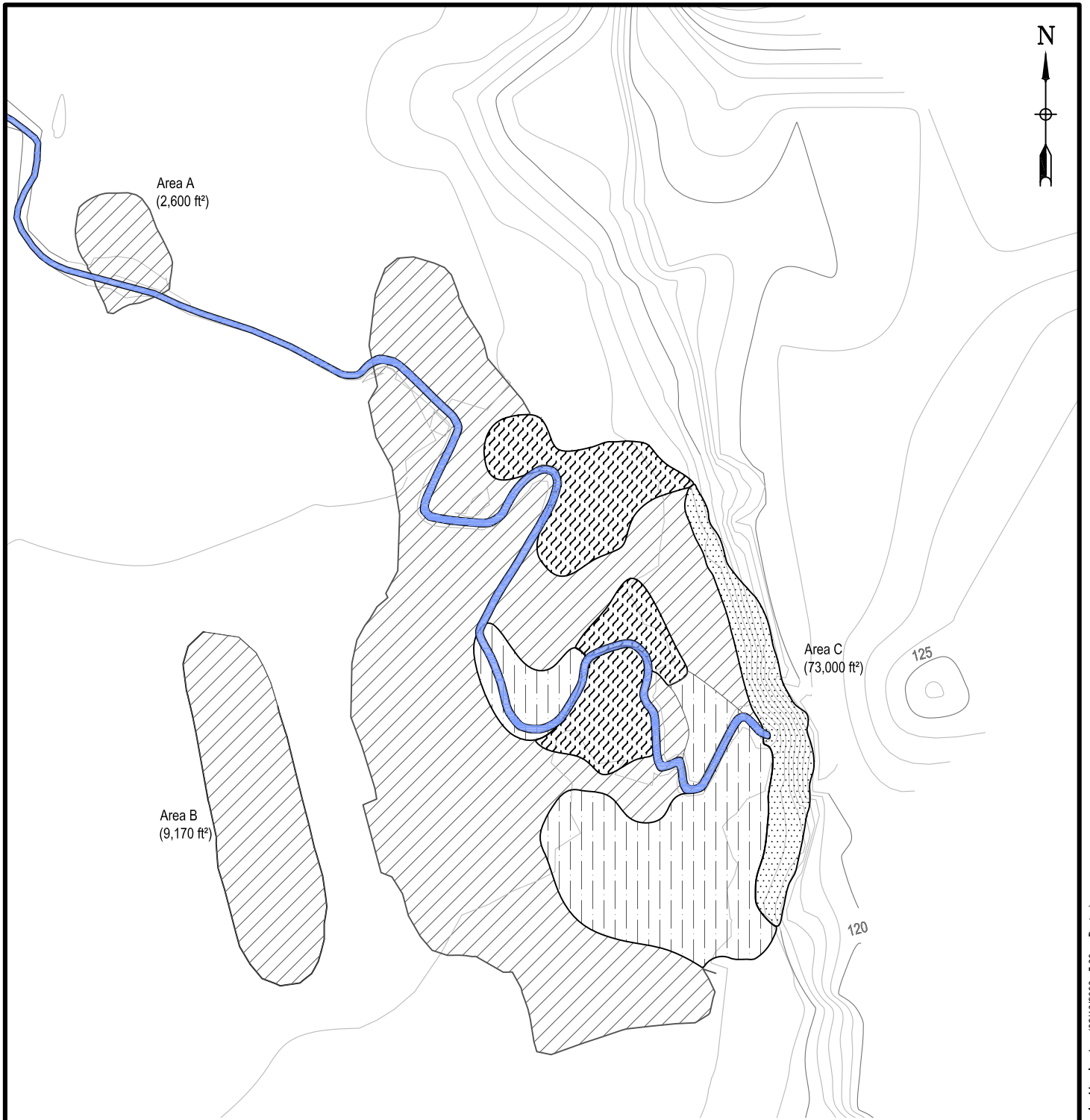
Enclosures

cc: Louis Burkhardt, Raytheon Company  
Benson Gould, CMG  
Public Repositories










## REFERENCES

- Bender, J. and J. Rendell, 2001. Element Stewardship Abstract for *Lythrum salicaria* (Purple Loosestrife). The Nature Conservancy, Arlington, VA.
- Blossey, B. 2003. Information for Ordering Biological Control Agents for Purple loosestrife. Cornell University – Ecology and Management of Invasive Plant Species Program. 5pp.
- ERM & Woodlot Alternatives, 2003. Single Environmental Impact Report and Notice of Intent for the Remediation of Oil and Hazardous Materials in Sudbury River Floodplain Wetlands, Wayland, Massachusetts. 15 May 2003.
- ERM, 2006. 2006 Wetland Restoration Monitoring Report. Prepared for Raytheon Company. 15 December 2006.
- ERM, 2007. 2007 Wetland Restoration Monitoring Report. Prepared for Raytheon Company. 14 December 2007.
- Tu, M.; 2000. Techniques from TNC Stewards for the Eradication of *Lythrum salicaria* (purple loosestrife) and *Phragmites australis* (common reed) in Wetlands. Dep. Of Vegetable Crops & Weed Sciences, University of California -Davis.
- Woodlot Alternatives, Inc., 2004. 2004 Wetland Restoration Monitoring Report. Prepared for Raytheon Company. December 2004.
- Woodlot Alternatives, Inc., 2005. 2005 Wetland Restoration Monitoring Report. Prepared for Raytheon Company. December 2005.

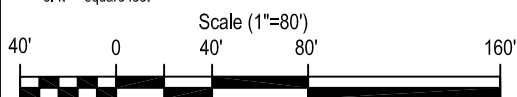


**Legend**

-  Stream Habitat (Includes Non -Invasive Vegetative Communities in Stream Channel) - 2,940 SQ.FT
-  Wetland Communities: Native, Non-Invasive Dominant Species - 53,700 SQ.FT
-  Wetland Communities: More Than 25% Areal Coverage of Invasive Species (Purple Loosestrife) - 14,150 SQ.FT
-  Wetland Communities: More Than 25% Areal Coverage of Invasive Species (Barnyard Grass) - 9,330 SQ.FT
-  Upland Communities: Less Than 25% Areal Coverage of Invasive Species - 4,650 SQ.FT.
-  5' Topographic Contour
-  1' Topographic Contour

**Notes:**

1. Vegetative Communities were Field Estimated by ERM on 9/28/07.
2. Stream Segment in Area A is Vegetated.
3. ft² = square feet



**Figure 1 - Invasive Species Mapping  
Former Raytheon Facility - Wayland, MA**



**Table 1**  
**Summary of Invasive Plant Control Strategies**  
**Former Raytheon Facility**  
**Wayland, Massachusetts**

Species	Mechanical	Chemical	Biological	Preferred Method
Purple Loosestrife <sup>1</sup>	Least effective	Most effective short and long term <sup>2</sup>	Effective long term <sup>3</sup>	Chemical and/or Biological
	Seed bank in soil will remain viable until exhausted. With about 25% cover over the restoration area, a seed bank in the soils, a continuing seed rain, existing stems intermingled with other vegetation, and the ability to resprout from broken stems and root fragments, no significant long-term reduction in cover can be achieved through mechanical control methods, even with extensive labor expended multiple times during the growing season.	Commonly used safely and effectively with precisely targeted treatments by licensed applicator that result in significant mortality of loosestrife without detriment to native plants. Leaves only new sprouts from the seed bank and seed rain for follow-up control. Follow-up treatments to address new sprouts from the seed bank and seed rain are required to effect long-term control.	Leaf eating <i>Galerucella</i> beetles defoliate and reduce plant vigor to eliminate flowering and seed set. Does not eliminate plant but, after 3-5 year period of population establishment, reduces loosestrife dominance and allows native plants to compete. Biocontrol allows for the possibility that control insects will be effective not only at this location, but may become established in other loosestrife stands throughout the watershed.	Targeted chemical treatment proven to provide the most effective short- term and, with repeat treatments, long-term results. Likely the only possible method to suppress purple loosestrife enough in the short term for the vegetative cover success standards to be met. Requires repeat treatments. Biological control is less effective in the short term but provides best option for long-term, widespread control. Results are not observed for several years. Does not reduce the number of individual plants, only limits the vigor and seed production.
Barnyard Grass	Least effective	Effective long and short term	N/A	Mechanical
	Seed bank in soil will remain viable until exhausted. It is anticipated that %-coverage by this species will slowly decline due to long term wetland hydrology that is not suitable culturally for this species. Species is intermingled with native species, making it time-consuming to select and cut without pruning desirable vegetation.	Chemical control can be used safely and effectively against barnyard grass with precisely targeted treatments by licensed applicator resulting in significant mortality of without detriment to native plants. Leaves only new sprouts from the seed bank and seed rain to control	No effective biocontrol agent available.	Limited long-term threat does not justify chemical control. Perform 3 annual rounds of cutting as seed heads set but before ripe. Approximate timeline early July through mid-August. Collect and dispose of seed heads off-site.
Cattail	Least effective	Effective short and long term	None	None
	Very limited cover is present; plants are interspersed with native vegetation. Seed heads could be cut. However, vegetative reproduction will continue. At present, the pace of spread is not a concern. Continuing presence of a small percentage of this potentially native species is not ecologically problematic.	Chemical control commonly used safely and effectively with precisely targeted treatments by licensed applicator resulting in significant mortality of without detriment to native plants. Leaves only new sprouts from the rootstocks to control. Requires multiple treatments	No effective biocontrol agent available.	Limited long-term threat does not justify chemical control. Hand pulling established plants is not feasible. Hand cutting of inflorescences will not result in a significant decrease in cover. The pace of spread is not a concern and a small percentage of this potentially native species is not ecologically problematic.

<sup>1</sup> Purple loosestrife is the primary control target due to its tendency for prolific spread, current densities of this perennial plant in the restoration area, seed bank in soils, and suitable cultural conditions.

<sup>2</sup> DEP Application Permit required.

<sup>3</sup> USDA-APHIS Permit 526 needed.