INTEGRATED PEST AND INVASIVE SPECIES MANAGEMENT PLAN

for the

ALBANY RAPP ROAD LANDFILL ECOSYSTEM MITIGATION, RESTORATION & ENHANCEMENT PROJECT

CITY of ALBANY, NEW YORK

Applied Ecological Services, Inc.

April 2009

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CITY of ALBANY, NEW YORK

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INTRODUCTION

A plan for restoring and managing native plant communities associated with the Eastern Expansion of the City of Albany Rapp Road Landfill is detailed in a separate document entitled Albany Rapp Road Landfill Ecosystem Mitigation, Restoration & Enhancement Plan (Applied Ecological Services, Inc. 2009). To meet the requirements of the NYSDEC 401 and Article 24 Freshwater permit condition, an Integrated Pest Management (IPM) and Invasive Species Management Plan was prepared.

This report provides strategies and techniques for controlling and managing both invasive animal and plant species known to occur in the Albany Rapp Road Landfill property including the proposed restoration area. The plan also considers potential invasive species (pests) that could become problematic in the future. For purposes of this plan invasive species are those that have been introduced or moved from their native habitat (intentionally or unintentionally) to a new location and have become established and spread with little or no competition from native species. Integrated Pest Management (IPM) is an effective and an environmentally sensitive approach to managing such species that relies on combining complementary control practices. An IPM program uses current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available control methods, is used to manage impacts by the most economical means, and with the least possible hazard to people, property, non-target organisms, and the environment.

The NYSDEC defines IPM as a "systematic approach to managing pests which focuses on long-term prevention or suppression with minimal impact on human health, the environment and non-target organisms. IPM incorporates all reasonable measures to prevent pest problems by properly identifying pests, monitoring population dynamics, and utilizing cultural, physical, biological or chemical pest population control methods to reduce pests to an acceptable level" (NYSDEC 2004a).

An IPM regime can be quite simple, or sophisticated enough to be a system in its own right. The main focus of this and most IPM plans is the management of all naturally occurring biological threats. The Albany Rapp Road Landfill IPM plan has been designed to be simple and easy to implement, and intends to achieve and apply the following components:

1. **Acceptable pest levels**: The emphasis is on control, not eradication. IPM holds that wiping out an entire population is often impossible, and the attempt can be more costly, environmentally unsafe, and frequently unachievable. It is better to decide on what constitutes acceptable levels, and apply the appropriate or a series of appropriate controls if the population of the acceptable level is exceeded.
2. **Preventive cultural practices**: Selecting plant varieties best suited for local growing conditions, and maintaining healthy plantings, is the first line of defense.
3. **Monitoring and identification**: Regular observation is the cornerstone of IPM. Visual inspection and other measurement methods are used to monitor pest levels. Record-keeping is essential, as is a thorough knowledge of the behavior and reproductive cycles of target species. Not all weeds and other living organisms require control.
4. **Mechanical controls**: Should a species reach an unacceptable level, mechanical control methods are the first option to consider. They include simply hand-pulling plants, mowing, erecting barriers for animals, using traps, and tillage to disrupt growth.

5. **Biological controls**: Natural biological processes and materials can provide control, with minimal environmental impact, and often at a lower cost. The main focus at the Albany Rapp Road Landfill mitigation site is on promoting beneficial insects that eat target plant species such as the beetles and weevils used for biological control of purple loosestrife.
6. **Chemical controls**: Synthetic pesticides and herbicides are generally used only as required and often only at specific times during the target species life cycle.

The IPM plan provides a variety of management techniques for the control of invasive species of plants and animals that are currently onsite and those that are the most likely problems at the Albany Rapp Road Landfill site in the future. These management strategies are to be used singularly or in combination to control a pest species or minimize its' impact. In most instances of plant and animal pests, the use of herbicides and pesticides are often integrated in management plans. The goal of the IPM plan is not only to integrate the use of herbicides and pesticides, but to integrate the use of alternative management activities that have been developed or may be developed. If pests are at levels where natural and/or synergistic management techniques are appropriate for attaining the projects performance standards, careful consideration of their use has been evaluated.

Previous attempts to establish some types of Pine Bush communities at the landfill have met with mixed success. For example, vegetative test plots were installed on the landfill clay cap but did not establish well, as the soil types were not the necessary sandy soils found in the Pine Bush. The mobile home park to the north of the landfill was dedicated to the APBP by the City. However, there was never an obligation on the part of the City to restore the mobile home park to Pine Bush habitat and, until more recently when concepts were developed by the City's consultants and discussed with APBPC and DEC staff as the result of the current landfill expansion proposal, no comprehensive plan existed for how that parcel would be restored and managed.

The current Eastern Expansion proposal presents a unique opportunity to look at the landfill, the mobile home park, and surrounding Preserve lands as a whole. As a result, the City retained Applied Ecological Services, Inc. (AES), a nationally recognized ecological restoration firm with specific expertise in pine barren communities. After an initial field visit, issues and concerns were identified within the landfill and surrounding areas and restoration concepts were developed that were used to begin a dialog with the APBPC technical staff. Next, the project team began detailed investigations of the vegetation, soils, and hydrology within project impact areas, degraded areas, and high quality reference areas (see results in Section 3 of the SDEIS), and used this data to refine concepts and to further engage the APBPC technical staff. This process provided the foundation for developing the Ecosystem Mitigation, Restoration & Enhancement Plan presented under separate cover.

Following is a summary of the important issues we identified during the field investigations that provide the basis for undertaking ecosystem restoration to address the mitigation needs of the project.

1. Existing Hydrology and Degraded Water Quality

Two streams once originated in the Pine Bush and were tributary to Lake Rensselaer. The tributary remnants exist today and are generally in their natural state east of Rapp Road. However, agriculture and development activities to the west of Rapp Road have significantly altered the character of the streams.

The southern tributary of Lake Rensselaer flows through the wetland on State land to the east of the landfill. This stream has been relocated and channelized or ditched as a result of agriculture and development and is currently connected to a pond located on APBP lands west of the landfill. The result of the stream ditching and draining within the wetland east of the landfill is a more rapid decay of the organic soils that comprise the majority of the wetland. This organic soil decay releases nutrients to the surface water and contributes to nutrient loading down-stream, which may well be a major cause of eutrophication within Lake Rensselaer.

Evidence of the draining effect of the ditching is visible in the orange-colored iron flocculent present in the ditch. It is likely that the flocculated iron results from the high-iron content of the soil weathered under oxygen-rich conditions (due to soil dewatering), forming free iron oxide (Fe_2O_3) that is only weakly bound to the sandy soil. Water moving through the sands can displace the flocculated iron and leach it in solid form into the stream. As long as the stream retains high dissolved oxygen content, the iron flocs will be noticeable in the stream. This process is naturally-

occurring in areas with iron rich soils and ground water and a high level of reducing and oxidizing conditions that will affect the solubility, mobility, and reformation of iron compounds.

In many locations within the proposed restoration areas, iron loving bacteria participate in precipitating the iron flocculent material. Typically these bacteria create gelatinous masses of orange, iron-rich material along shorelines of lakes, wetlands, and streams where ground water seeps and springs are found. This flocculent is most evident on State-owned lands to the east of the landfill where the dredged and channelized former agricultural ditch was previously excavated (by farmers approximately 50 years ago or more) deep into the underlying soils, intercepting the iron rich ground water and precipitating the flocculent behavior in the dredged channel locations.

The northern tributary once passed through the area that is now the mobile home park. The stream was ditched west of the mobile home park and redirected to the southern tributary. The northern tributary originates in a wetland located near the northwest corner of the mobile home park. There is no evidence that this ditch is receiving drainage from the lands to the north of the railroad tracks in this location—no culvert was found. East of the mobile home park, the stream was ditched and collects drainage from the northeast corner of the mobile home park and possibly from areas on the north side of the railroad. The drainage is conveyed east and south to a man-made pond, through a culvert and back to an open ditch out to Rapp Road.

The manipulation of drainage through construction of the mobile home park, access road, and the railroad have significantly changed the natural characteristics of the streams and have decreased water quality by providing sources of pollutants.

2. Existing Community Types

The proposed expansion located northeast of the existing landfill includes two community types, a forested wetland and a forested upland. The forested wetland is dominated by red maple (*Acer rubrum*) with an understory of green ash (*Fraxinus pennsylvanica*), black cherry (*Prunus serotina*), and Japanese barberry (*Berberis thunbergii*). The herb layer dominants include clearweed (*Pilea pumila*), common reed (*Phragmites australis*), cinnamon fern (*Osmunda cinnamomea*), and spotted touch-me-not (*Impatiens capensis*). Soils are dewatered by ditching which has allowed invasion by black cherry an upland tree. This community corresponds generally to the Red Maple-Hardwood Swamp classification used by the New York Natural Heritage Program (Reschke, C. 1990. Ecological communities in New York State, New York Natural Heritage Program, New York State Department of Environmental Conservation, Latham, New York.)

The upland forest consists of a canopy dominated by black cherry, northern red oak (*Quercus rubra*), and black locust (*Robinia pseudoacacia*), with black cherry and blackberry (*Rubus allegheniensis*) in the shrub layer. The herb layer dominants include white snakeroot (*Eupatorium rugosum*), garlic mustard (*Alliaria petiolata*), Kentucky bluegrass (*Poa pratensis*), and oriental bittersweet (*Celastrus orbiculatus*), the latter two being aggressive exotic invasive species. The composition of the upland forest corresponds to Successional Southern Hardwood Forest according to the Natural Heritage Program classification.

With the exception of the developed portions of the residential properties located southeast of the landfill, the lands proposed for facility relocation are forested with a mix of oaks, black cherry, black locust, and remnant pitch pine (*Pinus rigida*).

As previously mentioned, the habitat assessment performed for the project study area revealed that the Expansion Area and all the areas proposed for restoration are degraded ecological communities, having been modified by past land uses such as farming, mining, and development (Fox Run), and by fire exclusion. All of these activities have impacted drainage, soils, and native vegetative communities. A detailed discussion of the condition of the existing habitats is presented in Section 3 of the SDEIS. The Monitoring Plan provides for the establishment of permanent vegetation study transects in the expansion area from which baseline data has previously been gathered and from which future monitoring activities are proposed (Appendix E).

3. Existing Soils

The project area, including the restoration areas, are comprised of Colonie loamy fine sand, Elnora loamy fine sand, Granby loamy fine sand, Pits, Gravel, Stafford loamy fine sand, Udipsamments, and Adrian muck. These soils series are generally described by deep, excessively drained loamy fine sand to sand, with variations between horizons stemming from small gradations in texture and/or organic matter content. The soil horizons are deep, typically much greater than 60 inches and are generally described in the following sequence:

0 to 12 inches (± 3 inches):	loamy fine sand
12 to 25 inches (± 5 inches):	fine sand to loamy fine sand
25 to 60+ inches:	sand to fine sand

Soil samples from the lowland and upland series were collected throughout the project area and in ecological reference areas (examples of high quality ecological communities proposed to be replicated within the project area). The results of the soil study are included in the SDEIS. A summary of the soil analysis results is presented in Appendix 2 Construction Specifications addressing soil mitigation requirements in The Albany Rapp Road Landfill Expansion Ecosystem Mitigation, Restoration and Enhancement Plan provided under separate cover. In general, lowlands mapped include soils found in wetlands, typically where water flows and collects, or where the topographical aspect is low and intercepts the water table, creating perennially wet conditions. The typical upland soils in the Albany Pine Bush were found on ridge tops and side slopes.

4. Disturbed Pine Bush

In late 1960's or early 1970's, prior to the creation of the Albany Pine Bush Preserve and the APBP Commission, the City began land filling at the Greater Albany Landfill (GAL). About this time, Fox Run Estates (formerly known as Whitestone) mobile home Park was constructed. Prior to that, lands north of the landfill were mined for the sand. These activities had a direct impact on Pine Bush habitat and also contributed to a suite of other habitat barriers now found on the land between Pine Bush habitat to the east and west resulting from other development in the area.

Overall, the landfill is but one use within the Pine Bush landscape that has directly impacted or fragmented Pine Bush habitat. Long before the landfill was constructed, other development consumed large areas of the Pine Bush. The fact that the Pine Bush was not officially recognized as important habitat until the mid-1970's when the State, City of Albany and other municipalities purchased lands for preservation, and that the Albany Pine Bush Preserve Commission was not established until 1988 led to the current fragmentation of the remaining habitat.

Additionally, the detailed evaluations of habitat adjacent to the Rapp Road Landfill and archeological investigations revealed the historic uses in this area that created east-west habitat fragmentation long before the landfill and mobile home park were created. Historic photos, the ditched drainage, and remnant drain tiles revealed the agricultural activities that occurred in the large wetland area located east of the landfill.

There is a long history of disturbance and fragmentation within the current Pine Bush boundaries as defined by APBP and beyond. The restoration plan provides an opportunity to begin to erase a century or more of separation between east and west.

Other secondary impacts have included edge effects where the Pine Bush habitat has degraded due to lack of fire maintenance and the migration of imported landfill soils from the landfill slopes into the Pine Bush-landfill interface, changing chemistry and promoting more invasive species.

Other properties to the east of the mobile home park and the landfill were originally in private ownership and were not maintained as Pine Bush communities. In particular, the State-owned land to the east of the landfill was farmed at one time and later considered for commercial office development. It was this development project that spurred the State to propose a land swap, preserving the parcel. During the period of time the land was farmed, the large wetland area was tiled and drained to the southern, unnamed tributary of Lake Rensselaer that flows directly through the property. The stream was ditched (widened and deepened) to promote drainage, which has degraded the wetland.

RESTORATION & MITIGATION APPROACH & DESIGN

1. Ecosystem Restoration & Adaptive Management

Ecosystem Restoration

The intent of this ecosystem restoration plan is to create ecologically functioning biological communities within the context of a developed or disturbed landscape. The goal of restoration, enhancement, and creation—creating a quality environment—is represented by the plant life in the form of native plant communities. The assumption is that if the plant communities are restored and managed, wildlife populations, ecological functioning, and human enjoyment will be enhanced. This restoration plan provides information that will serve as a baseline for assessing the effectiveness of future activities and management efforts.

This project focuses on creating and restoring diverse ecological systems in and or adjacent to the Albany Pine Bush Preserve that currently are comprised of lower quality forested wetlands and other altered lands and including former agricultural lands now called forested wetlands and owned by the State of New York. Historic vegetation, along with other information on the existing conditions of the land was used as a reference to guide the restoration work. It is the intent of this project to create plant communities that are native to the area, and to the site. Changes in the landscape and existing conditions preclude the possibility of re-creating the original landscapes present 150-200 years ago, and not the intent of this restoration plan.

Where plant communities are adjacent to developed or traditionally landscaped areas, the plan will integrate the native planting with the adjacent lands, by creating transition areas that act as buffers to protect these areas, and to visually transition between the differing land uses. Properly designed and maintained native plantings of shrubs, wildflowers, and grasses will result in an intriguing, often stunning display of color and form. These will blend into the more natural conservation areas or provide a transition from restored plant communities to the developed areas.

Adaptive Management

Once restoration of the native plant communities is undertaken, there will be a necessity for management. These native plant communities are not self sustaining and will require periodic management. The mitigation enhancement and management program needs to be flexible because of the variability exhibited by the temporal and spatial resources addressed by this plan. Programs need at times to be changed in response to new data and derived insights. For these reasons, the restoration program and this IPM plan should be viewed as being neither conclusive nor absolute. The performance commitments, in other words, the diversity and plant communities targeted as outcomes are firm, but the planting zone acreages of each may vary from the plan. For instance, depending on final hydrology, less vernal pond acreage and greater sedge meadow acreage may result. This should not be thought of as a failure or an unwanted outcome. Restoration and management plans depicted on a map need to be flexible. This IPM program is a starting point in an ongoing process of restoring the site's biodiversity and natural processes. Regular monitoring throughout the project's phases is anticipated to begin in 2010. This monitoring will provide feedback on the program's effectiveness and generate information to evaluate and justify the need for changes. This process of evaluation, adjustment, refinement, and change is called "Adaptive Management." Adaptive Management is a tool that is fundamental to the restoration, management,

and maintenance needs of the Albany Rapp Road Landfill Ecosystem Mitigation, Restoration, and Enhancement Project.

2. Functional Benefits

Restoration, enhancement, and creation of native plant communities improve the health of ecosystems, including wildlife habitat and ecological function (e.g. stormwater management). The restructuring and management of integrated native woodland, wetland, prairie, and savanna vegetation complexes, with increased biodiversity and productivity, provides an opportunity to preserve and enhance the richness and productivity of native breeding birds, invertebrates, mammals, and other species that are present, that have been present, or that could be attracted to the restored project site.

By fostering and planting deep-rooted and fibrous rooted plants, the installation and enhancement of native plant communities stabilizes and improves soil, captures and slows runoff from current agricultural lands, and speeds the absorption of water into the soil and groundwater. Reduction of shade increases the light reaching the ground, stimulating shade suppressed native grasses, sedges, and wildflowers to bloom and vigorously grow. Hidden from view, but as important, the leaching of nitrogen and phosphorus that typically occur in agricultural lands can be a major contributor to water pollution and algae blooms. This leaching process will be slowed and water quality downstream improved by planting diverse wetlands and prairies. Other functions, from seed bank replenishment to the provision of food for wildlife, are enhanced by restoration.

3. Habitat Creation, Restoration & Enhancement

Creation as applied to wetlands is the process of making a new wetland in lands that were not previously occupied by wetlands. Wetland creation requires the most extensive construction and manipulation to achieve appropriate soil and hydrological conditions to support wetland vegetation. The most successful created wetlands are constructed adjacent to existing wetland or aquatic communities. Pine Bush Vernal Pond and sedge meadow wetland creation is planned to take place in old field areas west of the mobile home park. This created system will be linked to existing restored wetlands to provide improved habitat quality.

Restoration refers to the process of re-establishing an ecological community type that once existed in a given area but was previously eliminated in favor of other uses. By this definition, restoration is planned to take place on the landfill and within the mobile home park. Both areas are developed, and successful reestablishment of Pine Bush ecology where it was originally, will require the establishment of the appropriate soils, hydrology, and vegetation.

Enhancement is the process of improving upon the ecological elements already present and involves far less construction and site manipulation than restoration. For degraded Pine Bush communities, enhancement will involve the removal of invasive and other non-fire tolerant species to reestablish Pine Barrens. Within the wetland located on State land east of the landfill, enhancement will include the reestablishment of hydrology that was manipulated many years ago through ditching and the installation of drain tiles.

4. Repair of Degraded Aquatic Resources

Natural drainage in the restoration and expansion areas has been impacted by historic drainage ditching, the landfill, the mobile home park, existing old agricultural tiles, soil drainage activities, the railroad, and development to the north and south. Lake Rensselaer and the two tributary stream corridors that cross the property have been significantly manipulated over the years. The intent of the restoration plan is to reconnect the streams across the existing trailer park, restore riparian corridors, restore wetlands, and improve water quality. Presently, the water has been diverted into ditches around the trailer park. The ditches are eroding and a source of impaired water quality that enters at least the southern arm of Lake Rensselaer.

Reconnection of both streams through the mobile home park in restored riparian wetland corridors, will allow the mobile home park to be integrated back into the Albany Pine Bush Preserve. The southern stream's new channel will meander through a riparian floodplain relocated to the north of the proposed landfill expansion area. The stream will be reconnected to its existing channel within the wetland located on State lands to the east of the landfill. From its reconnection to the culvert at Rapp Road, the stream bed will be partially filled to eliminate the draining effect it is having on the wetland. Weirs will be installed in selected locations along the stream to further promote an extended hydro period. The purpose of this ditch modification effort is to re-saturate the organic soils comprising the wetland to reduce the accelerated decay of organic material that is a primary suspect for nutrient loading and a potential cause of eutrophication in Lake Rensselaer.

The northern stream will reconnect to the forested wetland located on the west side of the mobile home park. Drainage from the wetland area southward to the southern stream will be eliminated in order to separate these two streams. The northern stream will pass through a forested riparian corridor that will improve water quality above that of the current road and mobile home park runoff.

5. Reducing Habitat Edge Effects

The primary ecological issues associated with the interface between the landfill and the Preserve from an ecological perspective is the impacts of stormwater runoff, lack of fire maintenance, and the presence of invasive plant species. The plan has optimized the set back from state lands by varying amounts. This was determined based upon the land availability, the activities anticipated to occur within these set backs, the required habitat continuity across the landscape, minimized landfill construction, and operational impacts over the life of the expansion period. This will ensure the seamless restoration and management of habitats will occur during and after closure of the landfill expansion.

Stormwater runoff will be addressed by the design and installation of a stormwater management system that will collect runoff from the landfill slopes and redirect it to a biofilter that will treat the runoff before it enters the Preserve. The current issues with stormwater runoff are associated with earlier phases of landfill activities (Greater Albany Landfill – GAL) when stormwater and landfill regulations did not require the capture and treatment of runoff.

Lack of current habitat management along the landfill edge, particularly to the west of the landfill has resulted in the spread of poplar (*Populus* spp.) and black locust. Fire management has not been used on the belief that methane was migrating from the landfill, which has since been shown to be unfounded. Recent conversations between APBPC staff and landfill personnel suggest controlled

burning is possible in the west landfill area. Therefore, between the elimination of stormwater runoff impacts and the renewed potential for maintenance by APBPC staff, the "edge effect" could be significantly reduced. Restoration efforts on the landfill cap will further contribute to a blending of existing Pine Barrens with the created habitat.

Criteria have been established and used in the restoration design for minimizing impacts from construction. Continued analysis of the "edge effect" will be conducted during site monitoring. The protocols for sampling have been established and will use the same methods used in establishing the baseline study of reference natural areas and in specifications attached to the restoration plan. These methods include sampling of soils, hydrology, topography, vegetation, and the development of criteria for minimizing impacts to the Pine Bush with future mitigation plans. The following specific evaluations will be provided by the methods that have been established with the base line study protocols:

- Soil chemistry impact evaluation
- Vegetation and invasive plant impact evaluation
- Fire suppression impact evaluation
- Buffer effectiveness evaluation

6. Mitigating Direct Expansion Impacts

Mitigation is an essential component of the expansion plan. The project will impact approximately 5.05 acres of existing forested riparian wetland associated with the ditched stream and dewatered hydric soils that occur in the expansion area. This loss can be compensated through the creation of new forested riparian corridors associated with the reconnected streams through the trailer park. By integrating new restored wetlands with proposed stream reconnections there will be reduced erosion of stream banks, providing the opportunity to beneficially improve water quality, in addition, to significantly improved habitat in the enlarged and continuous habitat features that will be restored in the present trailer park location.

Other opportunities for wetland creation and enhancement include the creation of a new Pine Bush Vernal Pond system on the disturbed sands located to the west of the mobile home park. This unique community type is present, but rare in the Pine Bush ecosystem.

In total, it is estimated that approximately 22 acres of wetland communities can be created with an additional 29 acres of wetland restoration and enhancement. An important point is that all this mitigation is tied into a restoration and enhancement plan addressing the larger issue of large scale habitat connectivity within the Preserve. At the end of 10 years, when the landfill closure is completed, there will be a total of approximately 259 acres of restoration, mitigation and enhancement, all of which will be permanently protected.

7. Proposed Mitigation Wetlands & Restored Upland Ecosystems

<u>Forested Wetland Enhancement (Red Maple Hardwood Swamp)—27.59 acres</u>
This broadly defined, highly variable hardwood swamp features a variety of hardwood species, many of which produce hard mast (acorns and nuts) which are high quality browse for many species of wildlife. In addition to this, the growth in the sapling and small tree canopy provides extensive bud and bark browse for animals during the winter months. This community also contains or adjoins

community elements of the riverine system, the vernal pool community type, and nearly every other palustrine and terrestrial community of the restoration area. The highly diverse community interactions and the diverse internal species structure of this community indicate that it can be a productive community in the site for wildlife.

However, the existing forested wetlands found in the State property are highly degraded and continue to demonstrate a modified hydrology and associated vegetation systems. And the restoration and enhancement plans are focused on reversing these trends. Currently, remnant agricultural drain tiles were found to be functioning and are located throughout this property on ~20-30 foot centers. These clay tiles drain the upper 18-24 inches of the hydric soils present in the wetland to the dredged agricultural ditch also present in this property. The dredged ditch has further eroded down into underlying substrates and this downcutting and the presence of the tiles both act to exacerbate the dewatering effect on the adjoining wetlands. This dewatering effect is not only contributing to impaired water quality (e.g. runoff in the ditch contains exfoliating, dewatered muck substrates that are eroding from the ditch banks, and also the entrenched ditch has encountered an iron rich and red-ochre discolored ground water found to be present below the surface soils which is now freely flowing into the surface waters of the ditch) but also allowing for invasive plant species such as garlic mustard, reed canary grass and even multiflora rose to colonize into the dewatered nutrient rich substrates.

Restoration will install several log grade control structures that will prevent the further down-cutting of this ditch, will help reverse this down-cutting by creating locations where the existing delivery of eroded substrates from the banks will be used by the stream to naturally backfill entrenched locations and to again bury the source of the discolored iron rich ground water. In addition, we will disable the tile systems which along with the surcharging of water in the ditch created by the small grade control structures will surcharge the hydrology again into the dewatered soils. This surcharging of water will prevent the further colonization by invasive plant species that require the dewatered soils presently found in the property. In addition, restoration will also be focused on directly managing to remove and reduce the invasive species that have already colonized the degraded site conditions.

We will also stabilize the eroding dredge spoil piles on both sides of the ditch by planting wetland grasses and other plants that can grow in such shaded environments in these soil types.

The restoration activities will not reduce the tree cover in the NYDEC property and are focused on affecting the positive hydrology and vegetation restoration outcomes. They will also have the direct effect of improved water quality downstream.

<u>Forested Wetland (Red Maple-Hardwood Swamp)—11.34 acres created, 2.0 acres restored; Forested Riparian Wetland (Red Maple-Hardwood Swamp)—6.04 acres created, 0.82 acres restored</u>
Observations made within the larger contiguous portions of this community showed that in some areas, including within the riparian corridor, red maple is the only canopy dominant. In other areas it was seen as a co-dominant with one or more other species of hardwoods, but most typically with swamp white oak or silver maple. Forested wetlands created in the mobile home park will be designed to have similar functions as the other more mature forested wetlands on the property. While in a "start-from-scratch" restoration, this community type will often require numerous years of forest growth to achieve the functions and values of the existing forested communities, this plan proposes a strategy to accelerate this establishment process. For example, the use of salvaged substrates and root masses of trees will immediately introduce tree, shrub and seed stock that will

quickly and vigorously sprout and grow. Within a period of several years a closed sapling canopy from these sprouts will result. However, during this transitional phase the created wet forests will provide habitat cover, some food sources, and a lush ground cover to assist in infiltration and provide some if not all of the functional values of the successional disturbed substrate swamp found in the area to be impacted for the landfill expansion.

As this community matures, the hardwood swamp will be dominated by red maple, green ash, swamp white oak, and American elm. The oaks will produce hard mast (acorns) which are high quality browse for many wildlife species. In addition, the dense growth in the sapling and small tree canopy will provide extensive bud and bark browse for animals during the winter months. The highly diverse community interactions and the diverse internal species structure of this community suggest this community type will become one of the most productive communities of the landfill property for wildlife.

Biofilter Wetland—0.69 acres created, 0.73 acres restored

The biofilter wetlands are primarily installed within the restoration plan to receive stormwater runoff waters from the landfill surface in the operational interim and after the landfill closure and restoration of the surface acreage occurs. This community is targeted to provide a basic diversity of appropriate native plant species that will act to slow and contribute to cleansing the runoff waters from the landfill surface and from service roads around the landfill. While this biofilters system will provide some food and cover for wildlife, this is a secondary outcome and not the primary purpose of the vegetation plantings in the biofilters. Wetland vegetation will absorb and adsorb some nutrients and thus reduce nutrient inputs entering the restored stream and associated restored riparian forests found downstream of the biofilters wetlands. The biofilters also are sized and planted to provide floodwater storage when high water and high rainfall events occur. The wetland plant community will provide aesthetic beauty and recreational opportunities for local residents and others who visit the site for activities such as bird watching and wildlife viewing.

An aggressive maintenance program will be focused on removing invasive plants (e.g. *Phragmites communis*) from the biofilters wetlands, and also debris and sediments that are likely to accumulate during the landfill interim operational period over the next 6-7 years before the landfill operations are closed and stabilized with native vegetation plantings as described below.

Pine Barrens Vernal Pond—1.12 acres created; 0.35 acres existing P4 Wetland Mitigation managed to control invasives only and not included in wetland credits for this project

The plan proposes to create a pine barrens vernal pond in a dry depression between forested and open sand dunes west of the trailer park. This area may have supported such a community prior to the filling, ditching, and regrading disturbance that occurred during construction of the trailer park. The creation of a vernal pond is a valuable opportunity for the Preserve to expand this rare habitat type important to amphibians and other faunal species of the Preserve. Pieziometric water data we have collected over the past several years have identified the variability of ground water surface elevations in the proposed restoration area. This data will be used during construction to set grades to intercept the shallow ground water allowing appropriate seasonal fluctuations and permanently saturated conditions that will support the reintroduced vernal pond vegetation. Plant species will include the dominant and characteristic mosses, sedges, grasses, and forbs, as well as shrubs such as meadow-sweet, hardhack, high bush blueberry, black chokecherry, and leatherleaf.

Sedge Meadow—0.63 acres created

The sedge meadow community will provide a diversity of plant species and will provide wildlife food

and cover. This sedge-dominated community will provide a vegetative transition zone between the pine barrens vernal pond and the restored native riparian forest communities along the restored stream. The sedge community and associated vernal pond are two of the rarest communities in the APBP and restoration of these communities in this location provides an asset of increasing value as local communities of these types are lost to continued land development around the Preserve.

Several non-wetland plant communities integral to the overall success of the restoration and mitigation program will also be restored or enhanced.

Dry Prairie/Sand Flat—45.0 acres restored; Dune and Dune/Barrens—4.55 acres restored; Native Plant Nursery—1.44 acres created

Reconnecting the APBP across the property currently occupied by the operational landfill, the trailer park and adjacent degraded old fields (e.g. west of the trailer park) will be primarily accomplished by re-establishing dry prairies and dune systems growing with dry prairie grasses and other native plant species. Initially, a small portion (1.44 acres) of the trailer park will be devoted to a native plant nursery to produce seed for the restoration, but later will be converted to dry prairie. The majority of the closed landfill surface will be restored to dry prairie (and scrub community–see below) and this represents a large acreage that will in the future provide ecological benefits to the Preserve. In particular, the restoration of these communities will be focused on reestablishing the plant communities that are important and necessary for expanding the Karner Blue Butterfly habitat in the APBP landscape. The dry prairie and dune restoration areas will be created in graded flats and created dune structure areas which are planted with little bluestem grass, lupines and numerous other plant species found in the reference area studies elsewhere in the Preserve. The expansion of these community types presents another unique outcome of the restoration program and increases the acreage and continuity of these very important and needed ecological communities in the Preserve.

Pitch Pine-Scrub Oak Barrens—121.93 acres enhanced; Pitch Pine-Oak Forest Buffer—30.92 acres enhanced

A matrix community type we refer to as Pitch Pine-Scrub Oak Barrens will be comprised of a native grass dominated vegetation with varying shrub and tree cover and woody species composition. Variants included within this matrix can include the true grass dominated barrens, along with the Pitch Pine/Scrub Oak Thicket and Pitch Pine/Oak Forest types which essentially are the same but which reflect differing time periods since last restructured by prescribed fire.

The pine barrens habitat is a dynamic landscape occupied by dry grasslands where fire frequencies and intensities restrict scrub oaks and tree growth. In slopes and draws and extensive flats, trees and scrub oaks have colonized, and while these are regularly managed with prescribed fire, they persist and are a part of the landscape plant community mosaic. The restoration plan includes the restoration of these forest and thicket communities in some locations to compliment the mosaic and connectivity desired over the Preserve. These areas will be restored by planting the same matrix of dry prairie grassland as described above, and then by modifying the fire management program and planting oaks, native shrubs, and many of the other herbaceous and graminoid plant species found in reference natural areas of the Preserve. Some existing upland forested areas that provide a buffering function against the New York State Thruway and developed lands to the east will be enhanced as Pitch Pine-Oak Forest. Where these forested communities are highly degraded with few pine and oak canopy trees (adjacent to the highway), invasive species will be removed and native

tree species will be reintroduced over time. Less degraded forested uplands will require understory enhancement of the herb layer.

8. Restoration Program Summary

The activities associated with the restoration program will result in improved wetland functions over the existing degraded landscape and will restore native habitats in locations which currently do not contain any desirable ecological conditions. Falling into the last category would be the mobile home park, landfill surfaces, and degraded areas such as the ditch and tile drained former agricultural lands. The degraded water quality and accelerated stormwater releases being generated from these lands will be reversed with the restoration of ecosystem functions that will allow the land to hold water, reducing downstream flooding and improving water quality. Wildlife habitat that is currently restricted or non-existent for many species, including special status species such as the Karner blue butterfly, buck moth, eastern spade foot toad, and others, will be greatly and significantly expanded under the restoration program.

Restoration will involve earth moving in the mobile home park to remove existing imported topsoil that support ornamental and invasive plants, to create the landform and hydrology relationships that will support the desired restored wetlands and also the establishment of the dry prairie and pine barrens with sparse inclusions of scrub-forested uplands.

Restoration will also involve changing the cover on the landfill surface to desirable native dry prairie and scrub ecosystem as a part of the site closure. This will require killing the existing nonnative weeds and cover plantings, establishing a nutrient poor sandy rooting medium on top of the approved landfill cap, and planting dry prairie and scrub community into this new rooting medium.

Other sections of the IPM Plan layout the overall management philosophy to be employed, phasing strategies and plans, monitoring and maintenance programs, and management and restoration needs during the life of the restoration program. In addition, performance terms are defined to ensure that expectations are clearly understood among all parties, and most importantly, that triggers for success and any rollover of the perpetual responsibilities for management, maintenance, and monitoring occur in a logical, sequenced, and orderly fashion.

The restoration plan is committed to restoring all areas with the use of local-genotype native plant seeds and plants, and by use of management techniques that will stimulate any remnant seed bank that is present in some of the soil systems. These plant communities will be restored and created on bare soil, free of invasive non-native plant species by planting seeds, live plants, and other plant propagules and by using salvaged substrates from the wetlands that will be impacted as a part of landfill expansion.

There are opportunities for native plant (e.g. tree and shrub) and propagule (e.g. seed and acorn) salvage on the landfill Expansion Area. Salvage includes removing live trees and shrubs, gathering native plant seeds, acorns, and other fruits, and transplanting plants and soil from one location to another on site. From an ecological standpoint, this is beneficial because it preserves local genetic material that is adapted to local climate and soil conditions, thus, improving the chances for long-term survival of the planted material. It is also valuable from a cultural perspective because it attempts to preserve and transplant desirable native vegetation representing a natural history legacy, which would otherwise be lost in this area due to activities including construction and agriculture.

Acorns could also be harvested on site and directly seeded in restoration and enhancement areas, or if not germinating, over-wintered in cold storage and planted in the spring. Soil containing desirable native propagules or plants will be scraped from areas to be disturbed and spread in restoration and enhancement areas. While salvaging existing native vegetation from the new landfill Expansion Area site is not required for successful execution of a restoration plan, the opportunity to use this beneficial technique does exist and has been incorporated into the plans.

In 2009, if selected by the City for plan implementation/construction, we would propose to start to coordinate an expansion of the existing local seed collecting program in the APBP using AES nursery operations. On other projects where AES has done this, we have quickly and successfully initiated a substantial seed collection program and very large quantities of locally derived native plant seeds for eventual use in restoration. For example at the Seneca Meadows Landfill near Seneca Falls, NY seeds for nearly 100 species were collected for propagation and use in the restoration of the property. And for The Nature Conservancy in Indiana, AES seed collection crews (and local hired high school and other students and neighbors) collected over 300 species and thousands of pounds of seed annually for use in the Kankakee Sands restoration project. This strategy creates the best possible outcomes for local employment and community engagement, the development of a substantial local supply of seeds for species that are part of the diversity of places such as the APBP but that are often not commercially available from regional nurseries, and also establishes immediate conservation-based relationships between the City and land owners who have remnant Pine Bush habitat on their property.

In some projects we have paid adjacent landowners fees for allowing the collecting of seeds resulting in private landowners becoming committed to conservation of their lands. The lists of targeted species are provided in the Restoration Planting Schedule in the attached plan set. These lists are comprised largely of species recorded in baseline studies of reference Pine Bush communities, and augmented with species based on review of regional and local floras. Refinement of these lists will be made in collaboration with APBP experts and further research of Pine Bush floras [e.g. D. Rittner (ed). 1976. Pine Bush: Albany's Last Frontier; Barnes, J.K. 2003. Natural History of the Albany Pine Bush: Field Guide and Trail Map. NYS Museum Bulletin 502, Albany, 245p (contains Vascular Plant Species List compiled and edited by George R. Robinson and Kathleen Moore, State University of New York at Albany)].

IPM WORK PLAN & TARGET SPECIES

1. Program Structure and Implementation

Ecological restoration occurs in two general phases:

a) ***Restoration Phase***: The restoration phase is the period when major efforts are undertaken to restore, enhance, and create vegetation and biological diversity. This begins the process of restoring ecological functions. Tasks during this phase include reducing non-native and undesirable native species, restoring hydrology, mowing, seeding and planting of native plant species, and performing routine management activities.

b) ***Management and Maintenance Phase***: After achieving initial goals, the restoration, enhancement, and creation processes shift to a lower-cost, reduced-intervention management and maintenance program. Tasks during this phase include spot herbicide treatments, remedial planting, and other approved management activities. This may provide an opportunity for long-lasting personal involvement by local residents and/or employees in land stewardship. Direct involvement in site stewardship and conducting plant monitoring and bird-use assessments can provide an important, meaningful way to engage the community in the restoration project.

To conduct the native plantings and enhancements, ecological concepts and prescriptions are written and scheduled over a multi-year period for each of the several management units at the site. Management units are typically ecologically significant groupings of plant communities that are convenient to access and manage. After restoration is underway, and recovery of native plant communities ensured, the management plans are solidified and the management phase begins. Tasks are performed on a regular schedule, guided by annual ecological monitoring. Management strategies are usually completed on a rotational basis. For example, areas to be managed by prescribed burning are often split into management units demarcated by existing and convenient breaks, such as hiking trails or surface water features. While certain management tasks will occur only in particular management units in a given year, the annual monitoring and other annual management tasks will occur throughout the entire wetland mitigation project area. Appendices D and E provide details for implementing the management and monitoring activities required throughout the restoration area.

2. Scheduling

The planting and management schedule developed for the site is designed to produce healthy and sustainable ecological systems in the site's conservation areas. This program outlines an initial two-year construction and installation period followed by a ten-year management program with the option of making adjustments if necessary. Appendices D and E include monitoring methods, management methods, and performance standards. In this way the plan helps to ensure that the site will support healthy ecological systems over a long period of time.

3. Ecological Monitoring

Ecological monitoring provides important data about the effectiveness of the restoration and management program. Monitoring requires that the response of the native plant communities and often wildlife use be checked regularly by measuring ecological indicators of plant and animal community recovery (Appendix E). Effectiveness is judged against the goals and objectives of the project design. Goals can be modified over time as a result of this feedback. The results of annual monitoring are used to direct the management activities for the upcoming year, including the activities for invasive species management. Photography will be used to document a chronosequence of ecological change during restoration and management. Baseline ecological monitoring according to permit requirements was conducted in 2006, and the same methodologies will be replicated throughout the subsequent ecological monitoring period. The baseline reports are provided under separate cover and appended to the SDEIS and in the restoration plan document.

4. Reporting

In order to keep the regulatory agencies appraised throughout all phases of the project, a reporting schedule will be followed as laid out in the Monitoring Plan & Performance Criteria document in Appendix E (this document is also appended to the restoration plan).

5. Specialized Training and Required Qualifications for Restoration and Management and Monitoring

For many of the restoration tasks (e.g., herbicide application, prescribed burning, monitoring) specialized training (often involving licensing or certification), oversight, and guidance are required of personnel before and during the restoration program. Personnel involved in brush control, monitoring, seed collection, burning etc. should receive training commensurate with the activity undertaken. Training is especially important for those activities that may have risk and safety implications (e.g., herbicide application). New York State applicable training, certification, licensing and permitting required for herbicide application and storage will be obtained prior to implementation of this activity as part of the Integrated Pest Management strategy (NYSDEC 2004a, 2004b). A designated and permitted storage facility will be provided for the storage of necessary herbicides. In addition NYSDEC instructions for Applicator/Technician Pesticide Annual Report and Inspections documentation are also provided in Appendix C. Training is also important for monitoring, where an accurate assessment of the response of the ecological system to the restoration treatments is required. Retaining a qualified contractor to implement the restoration and management plan is essential for the successful completion of a project of this large size and complexity. Restoration ecologists, engineers, landscape architects and natural resource managers must be able to work together as an experienced team and have familiarity with one another and also have worked on projects of similar scope and complexity. The Landscape Contractor should have a minimum of ten years of experience in restoring natural communities, including wetlands and pine barren.

6. Construction Phasing

The construction phasing of the Rapp Road Landfill Eastern Expansion and the restoration earth moving needs will be coincident. It is the intention of the City to use the design team or equivalent to oversee and build the restoration programs included in this plan. Oversight by a highly qualified team of the grading activities will be essential to ensure that the very specialized grading needs

associated with the ecosystem restoration areas is completed accurately. Upon concluding the grading for the restoration areas (pine barrens vernal pond, sedge meadow, new stream channels, etc) the salvaged wetland soils and included selected areas with native plant stock materials found in the eastern expansion areas will be salvaged and placed in the receiving locations in the restoration zones. Minimal stockpiling of the salvaged materials is desirable or anticipated with the construction phasing plans proposed in this program.

The Phasing Plan depicted in the Plan Set illustrates the anticipated phasing of the project. The first phase will occur in Year 1 and will be concurrent with construction of the first landfill cell that will include overfill and expansion onto other currently disturbed lands. Wetland impact will be avoided in this phase and therefore wetland mitigation will not be the primary focus. However, this phase will provide the opportunity to prepare for wetland mitigation and the rescue of desirable species from the Expansion Area. During this phase, ecologists will begin the process of identifying and preparing species for transfer. A nursery will be established on the mobile home park site where some species will be transferred. For those trees that will stump sprout, roots will be cut and the trees will be allowed to adjust before it is transplanted.

Restoration during Phase 1 will focus on the establishment of pine barren test plots on portions of the closed landfill with the intent of demonstrating the viability of these natural communities on a capped landfill.

Phase 2 is identified as years 2 and 3 and will provide some very substantive results by restoring much of the mobile home park to pine barren and riparian wetland, reconnecting streams, restoring wetland hydrology, enhancing degraded wetlands, and improving water quality. Most of the wetland and stream mitigation work will occur in this phase.

Phase 3 (years 3 and 4) will again take on some significant restoration and enhancement efforts, particularly on the landfill, creating the pitch pine buffer along the Thruway, addressing stormwater and invasive species issues on the western edge of the landfill, and completing the east-west habitat connection with the restoration of pine barrens in the northeast portion of the project area.

Phases 4 & 5 (years 5-6 and 7-10) will focus on the landfill cap, restoring Pine Barrens to currently closed portions in Phase 4. Phase 5 will be part of the final closure of the landfill.

In order to support the unique ecological communities of the Pine Bush, the sands should come from the Pine Bush or possibly from other areas within the region with similar soils. The results of the detailed soils analysis performed as part of this SDEIS may also allow for the chemical modification of sands taken from other sources should there be no other options. Sands will be stockpiled and used as needed.

The success of this undertaking will depend partly on continued cooperation between the City and various stakeholders such as the APBPC, The Nature Conservancy, and regulatory agencies, as well as on the input received from the public during the SEQR and permit processes.

7. Closure Plan

When the Eastern Expansion reaches capacity, the landfill will be closed with the construction of a multi-layered cover system including a cushion layer, a barrier layer, a drainage layer, a barrier

protection layer, and a topsoil layer. The restoration and re-vegetation plan, as well as stormwater controls will also be included in the closure construction

The overall intent is to create dry prairie and Pine Barrens habitat across the landfill cap to provide Karner blue butterfly (*Lycaeides Melissa samuelis*) habitat for this federally and State listed endangered species, as well as habitat for other State listed species unique to the Pine Barrens community. This community type includes dry grasslands punctuated by occasional pitch pine trees and scrub oak (*Quercus ilicifolia* and *Q. prinoides*)

Demonstration Plots
The demonstration plots will be the early testing grounds for the larger restoration, enhancement and mitigation efforts. Examples of former restoration and demonstration programs for testing invasive species management and restoration strategies will be provided under separate cover

8. Construction Specifications

Complete Construction Specifications are presented in Appendix 2 of the restoration plan document provided under separate cover. Select specifications relevant to the IPM Plan are included in Appendix D.

9. Monitoring Plan and Performance Criteria

A detailed monitoring plan describing the monitoring requirements and performance standards for the wetland restorations and enhancements in the expansion and restoration areas is presented in Appendix E.

10. Third-Party Monitor Quality Assurance Plan

A Third-Party Monitor Quality Assurance Plan has also been prepared and provided in the restoration plan document under separate cover. The Third-party Monitor plan provides the qualifications and scope of responsibilities of a third-party monitor for overseeing and reporting on regulated activities in wetlands and other restored, enhanced, and created plant communities within the project area.

11. General Vegetation Management Tasks

Routine vegetation management tasks that will generally apply to the site include mowing, herbicide application, and prescribed burning to target and non target plant species (Table 1). Appendix D provides specifications for conducting the woody and herbaceous species herbicide, mowing and prescribed burning management tasks. Table 3 provides a list of potential herbicides that may be used to control targeted non-native and aggressive native invasive species. This list is not complete, as future New York State approved herbicides may become available that are more effective and/or provide fewer environmental impacts. Use of future New York State approved herbicides may be appropriate. Biological control will be implemented to targeted species that have had a proven record and have been approved by the regulatory agencies.

Mowing

Mowing is a physical non-selective activity that is effective in the early stages of the restoration activities. Mowing will be used most during the Construction and Restoration phases. It is an effective tool for managing non-native annual and biennial weeds in prairie and wetland restorations. **During the first growing season after seeding, as the vegetation reaches 12 to 18 inches, mowing to a height of 6-10 inches is recommended to control weeds.**

Herbicide and Pesticide Management

A wide variety of chemicals have been approved by New York State for the control of non-native aggressive weed species (Table 3). All herbicides to be used for the control of these species on the Albany Rapp Road Landfill site will be approved for that use and be applied by New York State licensed commercial applicators. Table 3 lists those herbicides and pesticides approved by New York State and may be used on the site.

The controlled pesticide applications at the site will be subject to NYSDEC review by the Division of Fish, Wildlife, and Marine Resources and the Bureau of Pesticides. Coverage under this IPM Plan will not relieve The City of Albany, or their contractor(s), from complying with any and all provisions of the pesticide program including certified applicators, compliance with product labels, and the need for an Article 15, Title 3, Aquatic Pesticide Permit (NYSDEC, 2004b).

Any pesticide use must comply with all federal and state pesticide laws, rules and regulations, including but not limited to:

- the business/agency applying pesticides must be registered
- all pesticide applicators must be made by a certified technician/applicator or a properly supervised apprentice
- all pesticide products must be currently registered for use in New York State
- all applications must follow/comply with label directions

Prescribed Burning

Fire is an essential natural process to the recovery of the fire dependent native barrens communities in the Landfill site and the surrounding Preserve. It is the least costly restoration and long-term management tool, and can be safely conducted by well-trained and well-equipped burn crews under the direction of professional burn specialists. Prescribed burning already occurs routinely at the APBP. The approach, if approved and permitted, will be to conduct small annual burns in selected management units, defined by artificial fire breaks (i.e. existing trails) and, to the extent possible, by the identified community type (prairie, sedge meadow, wet forest, or barrens). Prescribed burns are usually conducted more frequently initially due to the anticipated spotty distribution of effective burns and until appropriate fuel loads develop. Spotty fires are not necessarily undesirable, allowing a more patchy vegetation structure and limiting the impact to small populations of insects and other fauna. Eventually it is anticipated that prescribed burning will be applied to most areas of the wetlands and barrens at some point. As satisfactory fuel load conditions have been achieved, a cycle of 2-3 consecutive burns followed by a period of 2-3 or more yearly intervals can be expected to maintain a healthy barrens system.

Impacts of Burning to Vegetation

During the remedial phase of restoration, prescribed burns will be conducted preferably in the early spring (early to mid April) when optimal conditions for burning are most likely to occur. Early spring burning benefits the prairie and Pine Barrens community by:

- Controlling exotic shrub seedlings, which often flourish for several years following the cessation of agricultural activities,
- Releasing nutrients for immediate uptake by emerging vegetation,
- Inhibiting the growth of thin-barked, woody exotics such as common buckthorn from nearby woods,
- Enhancing early soil warming, and
- Native herbaceous plants are not harmed by fire; many are actually show enhanced growth,
- Controlling native overstocked native trees and shrubs to provide open prairie Pine Barrens habitat.

Impacts of Burning to Wildlife

It is generally expected that prescribed burning will have an overall positive effect on native wildlife communities with minimal impact on mammals. Larger mammals and mature birds can safely move away from fire. Rabbits are well out of reach of the fire just a short distance above the ground in prairies. Small ground mammals, such as mice can out run a fire line or find shelter in the ground and will be expected to experience subsequent population growth after a fire due to the increase in suitable ground cover as habitat and food. However, timing of spring burning can negatively impact ground nesting birds. Nevertheless, to avoid potentially burning eggs and newborn of nesting species, spring fires should be scheduled for mid to early April. Migrant and resident butterflies will benefit from prescribed burning by increasing the native plant diversity and the number of plants that may serve as larval hosts and nectar sources for adults.

Prior to the commencement of prescribed burning, a burn plan will be prepared that outlines a plan of action, identifies contingencies, and lists the names and phone numbers of emergency agencies (fire department, police department, etc.). Proper notice of intent to burn shall be given. The City of Albany shall apply for and receive all required permits prior to the commencement of prescribed burning. Generally, burning shall be conducted after the second and third full growing season in most restoration areas, and then once every three years or as approved by the Owner. Fall burns may be desirable or necessary, when weather or scheduling precludes a spring burn. Prescriptions for a fall burn will maximize safety and minimize smoke.

Key Actions & Strategies for Prescribed Burning

- Conduct annual prescribed burns in management units as laid out in the 10-year remedial restoration phase schedule, and develop a long-term fire management strategy, to be applied once remedial phase objectives are achieved. Apply a burn cycle rotation appropriate for each plant community type:
    1. Mesic and wet prairie communities, 2 to 3 consecutive years at approximately 2-3-year intervals.
    2. Wet forest communities, once or twice every 8 to 10 years.
- Schedule spring burns in early to mid April to avoid injury to low-nesting bird species, and to maximize safe burning conditions, i.e. cooler temperatures and moist conditions.
- Notify the immediate neighborhood and acquire the necessary local, state or federal burn permits well in advance of the scheduled burn.
- Prepare burn prescriptions that minimize smoke in the neighborhood.
- Use prescribed burning to achieve vegetation management objectives such as enhancing the growth of native species, stimulating prairie regeneration, and controlling exotic plant species. Specific targets associated with these objectives include:
    1. Prairie stand structure and understory ambient light levels that support ground layer vegetation.
    2. Patchy distribution of differing plant species.
    3. Continuous native grass, sedge and forb ground story that incorporates spatial variability.
- Initiate fire management in areas where sufficient plant litter (mostly grasses and sedges) is concentrated, and subsequently where brushing treatments have occurred and a sufficient fine fuel load has been established through re-vegetation efforts.
- Use well-trained and well-equipped burn crews for the prescribed burns, and continue public education and outreach on the ecological benefits of fire through articles in the local media.
- Monitor and document the effects of prescribed burn treatments, and adjust the burn prescription and management strategy accordingly.

12. Long-Term Management Program

It is anticipated that after the first five years of the 10 years of ecological restoration, enhancement, and management the project will transition into the long-term management program. The long-term management program is critical for maintaining the value of the investment, perpetuating the plant community, and maximizing the ecological and aesthetic benefits of the native plant communities. Management activities occur within designated management units. Appropriate management tasks for the entire conservation area and within particular management units will be guided by the annual monitoring. Monitoring provides the necessary feedback on the success of the restorations and enhancements. Monitoring also identifies developing problems, and is used to modify management techniques in order to achieve a higher success rate. Both long-term management and long-tem monitoring should be conducted in perpetuity. The City of Albany will take responsibility for monitoring, IPM management and maintenance for 10 years following construction of the wetlands

in Phase 2 (re-establishment of the riparian corridors in the mobile home park). Long term care and maintenance (beyond 10 years) will become the responsibility of the Albany Pine Bush Preserve Commission.

Use of appropriate physical (e.g., cutting) and chemical (e.g., herbicide) treatments will be necessary to control invasive plant species at the site, as well as other allowable management techniques.

The management tasks described in Table 2 is repeated at certain intervals for different plant communities. Repetition is necessary to ensure that the restored condition of the plant communities is maintained over the long term.

13. Selective Invasive Fauna Species Management

Several animal species can become pests and have a negative impact on the native flora which can cause significant damage to restored ecosystems. The most probable animal species to become pests at the landfill site are summarized below in descending order of being a potential pest, along with recommended methods for control. More detailed description of each faunal species and further potential control methods are found in Appendix A.

White-tailed Deer (*Odocoileus virginianus*)

The white-tailed deer is an herbivore, with a ruminant stomach allowing it to eat woody plants that other animals cannot digest. It feeds early in the morning hours and late afternoon. A deer's diet changes depending on its habitat and the season. It eats green plants in the spring and summer, and in fall, eats corn, acorns, and other nuts. In winter, it eats the buds and twigs of woody plants. White tail deer are anticipated to be the most problematic species at the Albany Rapp Road Landfill expansion site.

Mechanical Control Methods
The preferred option for mechanical control is the use of controlled hunting. Deer hunting is legal in the Albany Pine Bush. However, deer hunting will not be an option on the landfill while still under operation or on the trailer park area (until the remaining residents leave). Controlled hunts in other areas have been successful to reduce the population size of a herd. Selection of hunting techniques depend on local circumstances, including parcel size, deer numbers, problem severity, and the potential for animal right activist conflict. Archery hunting for deer has the advantage of being a relatively discreet and silent activity.

Fencing can also be a reliable method for addressing site-specific problems such as landscape or agricultural damage. Within the Albany Pine Bush Preserve this is not a likely option. Several factors should be assessed before using fencing as a deer control option. These include fence design, site history, deer density, crop or landscape value, local ordinances, and size of the area to be protected.

Canada Geese (*Branta canadensis*)

Canada geese can become problematic in wetland restorations as the habitat they use coincides with the wetland plant communities designed and installed. Geese will use the emergent zones and prefer as food most of the seed and plants used for the emergent zone restoration. In some locations, such

as major metropolitan areas, geese have become year round residents and no longer migrate. Geese may exceed the natural "Carrying Capacity" of the wetland system and through extensive herbivory pressure do not allow the wetland vegetation sufficient time to recover.

Several strategies are available to control geese density if they inhabit the site on a year round basis. During the initial plant installation period, emergent plants will be protected for up to 2 years with "goose exclusion" fencing. In the initial two years of native plant species establishment and in following years if goose populations attain an unacceptable level, especially those geese that no longer migrate, additional control methods other than "goose exclusion" fencing may be employed (Appendix A).

North American Beaver (*Castor canadensis*)

Introduction

The North American beaver was nearly extirpated in the early 1800s, but populations made a significant recovery in the 1900s through trap and transfers, harvest restrictions, and habitat recovery. During the 1960s and 1970s, wildlife biologists studied the wetland-wildlife benefits provided by beaver impoundments. Results from the study lead to major changes in beaver management. It was determined that the habitat and other benefits of beaver balanced many of the costs. After then 1980s, beaver populations were maintained at desirable levels through regulated trapping seasons.

Description

The beaver is the largest rodent in North America. Adults range from 35 to 46 inches in length, which includes the flattened tail (12-18 inches) and weigh between 45 to 60 pounds. The hind feet are very large with 5 webbed toes. Front feet are dexterous and small, which allows the beaver to carry various dam building materials. Its fur has a range in color but is typically dark brown. The coat is comprised of two different hair types, the outer section is coarse, long, and covers the inner layer which is much finer and is used for warmth. Beavers are mainly active at night. They are excellent swimmers but are more vulnerable on land, so they tend to remain in water as much as possible. They are able to remain underwater for as long as 15 minutes.

Habitat

Beavers live in streams, rivers, ponds, marshes, and shorelines of large lakes throughout North America, parts of Europe, and Asia. Beavers alter their environment on a large scale in order to provide shelter and protection. Beavers construct dams in areas which result in the formation of ponds. Within and around the pond, beavers construct canals for security and for the transport of building materials and food. Beaver dams and lodges are constructed of logs and mud, with some utilizing banks along streams or ponds. Beavers are not present in the Albany Rapp Road Ecosystem Mitigation, restoration, and Enhancement site but are known to occur in downstream areas such as around the lake Rensselaer. Beaver problems sufficient to adversely affect the restoration activities are currently not anticipated.

Control

Mechanical Control
Individual shrubs and trees can be wrapped in wire fencing, with a minimum height of 36 inches. Deep water fences can also be installed to prevent floodwater debris or beavers from blocking culverts or spillways. Water level control devices can also be installed.
The best control method for controlling beaver is removal. Open season for trapping beaver in New York is November 25 – March 15. During open season, the trapper/landowner partnership is the best long-term solution for beaver control. The trapper can remove nuisance beaver from the land during open season, when pelts are at their prime. Trapping methods include foot-hold and body-gripping traps. During closed season, landowners must obtain an Article 11 permit from the Bureau of Wildlife to trap or destroy beaver structures.

Muskrat (*Ondatra zibethicus*)

Introduction

The muskrat has been introduced practically all over the world, and, like most exotics, has caused severe damage and ecological problems. Muskrats often cause problems with ponds, levees, and crops, whether introduced or native to the area. Muskrats are found in most aquatic habitats throughout the United States and Canada, in streams, wetlands, ponds, lakes, drainage ditches, and swamps.

Description

The muskrat is a medium-sized semi-aquatic rodent in the United States. It spends its life in aquatic habitats and is well adapted to swimming. An adult muskrat ranges from 16 to 24 inches long, almost half of that the tail, and can weigh from 1.5 to 4 pounds. Muskrats are covered with short, thick fur which is medium to dark brown in color. Its hind feet are large and are partially webbed with stiff hairs aligning the toes. Its laterally flattened tail is almost as long as the body. When they walk on land, their tail drags on the ground, making their tracks easy to recognize.

Habitat

Muskrats are found in most of Canada and the United States. They are typically found in wetlands, areas in or near salt and freshwater marshlands, rivers, lakes, and ponds. Muskrats thrive in most of their native habitats and in areas where they have been introduced. While many wetlands have been destroyed by human activity, newly constructed canals and irrigation channels provide new habitats. Muskrats are also able to live along streams which contain sulfurous water that drains from coal mines. In shallow water areas with plentiful vegetation, they use plant material to construct houses, and in many habitats they construct both houses and bank dens with several underwater entrances with runs and trails. Muskrats are known to occur downstream of the expansion site, in and around Rensselaer Lake.

Damage by muskrats is primarily due to their burrowing activity. Burrowing may not be readily evident until serious damage has occurred. One way to observe early burrowing is to walk along the edges of waterways when water is clear, and look for trails just below the normal water level.

Control

Mechanical Control
Muskrats are very easy animals to trap. A number of innovative traps have been constructed for both live trapping and killing muskrats including barrel, box, and stovepipe traps. Each type of trap has specific locations where one might be more effective than another. The most effective traps are set in runs or trails where repeated use occurs in and out of the den. Place the trap as close to the den entrance as possible without restricting trap movement. Trapping season in New York is November 25 – March 15.

Muskrats, in some situations, can be excluded or prevented from digging into banks through the use of stone rip-rap. Damage can often be prevented by constructing dams to certain specifications, referred to as overbuilding. Using a 3:1 slope on the inside face, a 2:1 slope on the outer face with the top width of greater than 8 feet. The normal water level of the water body should be no less than 3 feet deep with a spillway wide enough that heavy rainfall will not increase water levels for any length of time.

The best way to modify a habitat infested with muskrats is to eliminate aquatic vegetation or other suitable food sources. Other methods of exclusion include the use of fencing surrounding areas of interest, particularly where vegetation is abundant. If this is not possible, water levels in water bodies can be drawn down to no less than 2 feet below normal water levels in winter. Then dens, burrows, and runs can be filled with rip-rap. Once the water is drawn down, muskrats can be trapped or otherwise removed.

Chemical Control
Only one chemical control method is federally registered for muskrat control, zinc phosphide at 63% concentration. Zinc phosphide baits for muskrats are generally made by applying a vegetable oil sticker to cubes of apples, sweet potatoes, or carrots; sprinkling on the chemical, and mixing thoroughly. The bait is then placed on floating platforms, in burrow entrances or near feeding houses.

Mute Swan (*Cygnus olor*)

A second avian species that can become problematic in the wetland areas, most notably the emergent zone, is mute swan. The mute swan (*Cygnus olor*), a native to Eurasia, was introduced to the North American continent from the mid-1800s through the early 1900s. Although mute swans are aesthetically pleasing, their potentially deleterious effects on native ecosystems are a concern to natural resources managers. There is only a small likelihood that mute swans will be observed on the project and even less likely to become problematic.

Detrimental Impacts on Native Waterfowl
Mute swans exhibit aggression toward other desired waterfowl, displacing native species from their breeding and feeding habitats, and sometimes attacking, injuring, or killing other birds. Year-round residency of mute swans on shallow wetlands can reduce submerged aquatic vegetation availability for native breeding and wintering waterfowl.

Detrimental Impacts of Wetland Habitat

Submerged aquatic vegetation (SAV) is a key component of wetland ecosystems. The plants are a major food source for native waterfowl. SAV beds also provide habitat and shelter for a variety of fish, shellfish, and many small invertebrates. The Albany landfill wetland mitigation restoration plan does not include the installation of submerged aquatic vegetation and the lack the necessary SAV should result in no or minor use of the emergent zones by mute swans. Much of the emergent zone is likely to dry up during summer months, creating only small open water areas. However as time passes, there is possibility of SAV establishment in some of the deeper wetland areas and mute swans may be detected on site.

Control

The New York Department of Environmental Conservation (NYSDEC) has developed a policy to prevent further growth of the feral mute swan populations. The NYSDEC encourages landowners to control swans on their own property. Measures that may be used at the Albany Rapp Road Landfill Ecosystem Mitigation, Restoration and Enhancement Site include harassment (scaring the birds away). Any swans removed must be adopted by individuals who are licensed to keep captive birds. Mute swans are protected by the New York State Environmental Conservation Law. Therefore, swans, as well as their nests and eggs, may not be handled or harmed without authorization from NYSDEC.

Emerald Ash Borer (*Agrilus planipennis*)

Introduction

The Emerald Ash Borer (EAB) is a shiny green beetle native to Asia. Since its accidental introduction into the United States, it has spread to seven states and adjacent parts of Canada. It has killed nearly 20 million ash trees to date, and threatens to decimate the ash trees throughout the United States. Emerald ash borer has not been found in New York State. Proactive, periodic visual inspection of ash trees to detect the signs of EAB should be conducted.

Signs of EAB Infestation

Ash trees may have EAB for several years before any signs and symptoms are recognizable. Signs and symptoms of an infested tree include:

- Delayed leaf-out in spring (symptom)
- Thinning canopy or crown (symptom)
- Branch dieback from top of tree (symptom)
- S-shaped tunneling under the bark (sign)
- Woodpecker damage (symptom)
- Epicormic shoots/water sprouts (symptom)
- Bark splits (symptom)
- D-shaped exit holes – first spotted in upper branches (sign)

Mechanical Control

Mechanical control once an infestation has been identified includes removal of all ash trees within a ½ mile radius of the infestation. This technique must be completed by a certified arborist and tree removal company, as to not spread the infestations further. This is the only certain method to control EAB. If EAB is found in the Rapp Road Ecosystem Mitigation Restoration and Enhancement Site, the appropriate mechanical control methods are recommended.

Chemical Control
Insecticidal control is used at this time in some States as a preventative to treat ash trees within 10-12 miles from known infestations. Control is more effective on smaller trees, with a trunk diameter of less than 10 inches. If many infested trees are nearby, approved insecticide(s) and other control are unlikely to protect trees due to the heavy onslaught of beetles from nearby infestations. If insecticides are used they will be New York State approved insecticides and be applied by licensed commercial applicators. If EAB is detected within a 10-12 mile radius of the Ecosystem Mitigation Restoration and Enhancement site, insecticidal control of approved pesticide should be applied to smaller ash trees as a preventable measure.

Biological Control
At this time, biological control techniques are still in the experimental stage. Further research is being conducted to find insect, fungal, or microbial bio-control methods.

14. Selective Invasive Plant Species Management

A number of non-native and a few native plant species can also become problem species in newly restored and enhanced plant communities at The Albany Rapp Road Landfill Mitigation site. Locating and controlling these local plant populations if located in surrounding areas owned by the City of Albany, prior to restoration activities can greatly help prevent the spread of these species into the newly restored areas. Locating the species when population numbers are low and immediately implementing management activities are essential components of the IPM Plan.

There area a number of non-native weeds that can be controlled by the general management activities of burning and mowing and are not detailed in the IPM Plan. The plant species of most concern are described briefly below based on plant community they are most likely to occur and in descending order of potential problem, beginning with the species that may be the most problematic listed first in each community. Table 1 provides a schedule for the appropriate times for control of plant species that may be require management at the site. A brief synopsis is included below for the most probable problematic species. Detailed plant descriptions and additional control methods can be found in Appendix B.

Potential Wetland Problematic Species

Common Reed Grass (*Phragmites australis*)

Introduction
Common reed grass has thick rhizomal growth and litter accumulation from aerial shoots prevents other species establishment. These common reed grass monocultures have decreased value as wetland habitat for wildlife. Common reed is an undesirable species in areas where stands are spreading and overtaking the habitat, and species typical of the community are diminishing. This species is the most likely aggressive and weedy wetland species that may be problematic on the Albany Rapp Road Landfill Project. It is currently found on most existing landfill side slopes and in open wetland areas that are part of the power line access corridors and other existing on-site wetlands.

Description
Common reed grass is a tall, perennial grass that can grow to heights of 15 feet or more. Broad, pointed leaves develop from thick, vertical stalks. Leaves are 6 to 23 inches long, 0.4 to 2.4 inches wide, flat and glabrous. The flower heads are dense, fluffy, gray or purple in color, and 5.9 to 15.7 inches long. Flowering occurs from July to October.

Habitat
Common reed grass can be found in roadside ditches, open wetlands, river banks, lakeshores, disturbed or undisturbed areas. Common reed grass prefers alkaline and brackish waters but will tolerate highly acidic conditions. It can grow in water up to depths of 6 feet, and in somewhat dry areas.

Mechanical Control
Mechanical control methods for common reed grass can include mowing, disking, dredging, flooding, draining, and burning. Because common reed grass grows vegetatively, these methods can actually increase its spread.

Chemical Control
Studies have shown that the best control method for common reed grass is herbicide application. Apply glyphosate or Arsenal to the plant's foliage in late August through October, prior to the first frost (Table 3). Additional herbicide applications in subsequent years will be necessary to provide long-term control.

Purple Loosestrife (*Lythrum salicaria*)

Introduction
Purple loosestrife displaces native wetland vegetation and degrades wildlife habitat. As native vegetation is displaced, rare plants are often the first species to disappear. Eventually, purple loosestrife can overrun wetlands thousands of acres in size, and can almost eliminate the open water habitat.

Description
Purple loosestrife is an herbaceous perennial plant, which typically grows 1 to 1.5 meters tall, forming clonal colonies with numerous erect stems growing from a single woody root mass. The stems are reddish-purple and square in cross-section. The leaves are lanceolate, 3-10 centimeters long and 5-15 millimeters wide, downy and sessile, and opposite or in whorls of three. The flowers are reddish-purple, 10-20 millimeters in diameter, with six petals and 12 stamens. The flowers are clustered tightly in the axils of bracts or leaves. The fruit is a small capsule, 3-4 millimeters, containing numerous minute seeds.

Habitat
Purple loosestrife is a wetland plant, growing in shallow freshwater pond edges, fens, and marshes, on fertile, neutral to slightly alkaline soils.

Mechanical Control
This method includes cutting, pulling, digging and drowning. Cutting is best done just before plants begin flowering. Cutting too early encourages more flower stems to grow than before. If done too late, seeds may have already fallen. If no seeds are visible, bag all cuttings (to prevent them from

rooting). If there is seed, cut off each top while carefully holding the plant upright, then bend it over into the bag to catch any seed that may drop.

Pulling and digging—can be effective, but can also be disruptive by creating bare spots, which are good sites for purple loosestrife reinvasion. Use these methods primarily with smaller plants in loose soils, since they do not leave large gaps, or root tips. Drowning young plants is effective if plants are completely submerged for one year.

Mowing—has not been effective with loosestrife unless the plants can be mowed to a height where the remaining stems will be covered with water for a full 12 months. Prescribed burning has also proven to be ineffective. Mowing and flooding are not the recommended control method because they can contribute to further dispersal of seeds and stems.

Chemical Control

Chemical control is usually the most effective method to manage and eliminate loosestrife quickly, especially with mature plants. Herbicides should be applied in late July or August, before flowering to prevent seed set. The best method for chemical control is to cut stems and treat stump tops with herbicide. Currently, glyphosate is the most common chemical used (Table 3). If standing water is present, Aqua Neat, a glyphosate formulated and New York State listed for use over water should be used.

Another method is spot treatment in large areas that have desirable vegetation. This can reduce costs for sites with large densities, and reduce the amount of accidental spraying. Triclopyr is another herbicide that can be used as a foliar spray. It is formulated to use around water and does not affect grasses or sedges. Foliar application must cover nearly all of the foliage.

Biological Control

Conventional control methods like hand pulling, cutting, flooding, herbicides, and plant competition have only been moderately effective on controlling purple loosestrife. Biocontrol is now considered the most viable option for more complete control for heavy infestations of purple loosestrife. A species of weevil, *Hylobius transversovittatus*, has been identified that lays eggs in the stem and upper root system of the plant; as larvae develop, they feed on root tissue.

In addition, two species of leaf-eating beetles (*Galerucella calmariensis* and *Galerucella pusilla*), and another weevil that feeds on the flowers (*Nanophyes marmoratus*) are being used to stress the plants in multiple ways. Research has shown that most of these insects are almost exclusively dependant on purple loosestrife and do not threaten native plants, although one species has shown some cross-over to native loosestrife. These insects will not eradicate populations, but may significantly reduce the size so cohabitation with native species becomes possible.

Integration of traditional controls and biocontrol has been found to be the best plan for many sites, since some immediate loosestrife control can be maintained while biocontrol insects become established enough to exert meaningful control. The level of a species infestation can also provide for the appropriate response. For example, the Table below provides the general guidelines for implementing the management activity at the Albany Rapp Road Wetland Mitigation Project based on the level of purple loosestrife infestation.

Purple Loosestrife Control Matrix for the Albany Rapp Road Wetland Mitigation

	Isolated Plants	Small Less than 1 acre (0.1 – 0.5 hectares)	Medium Up to 4 acres (0.5 – 2 hectares)	Large More than 4 acres (more than 2 hectares)
Low Density **1 to 50 plants** **(1-25% of the area)**	Chemical control Digging and hand pulling	Chemical control Digging and hand pulling Cutting	Chemical control Digging and hand pulling Cutting	Chemical control Cutting
Medium Density **50 to 1,000 (25-75% of the area)**		Chemical control Digging and hand pulling Cutting	Chemical control Biological control Cutting	Biological control
High Density **More than 1,000** **(75-100% of the area)**		Chemical control Biological control Cutting	Biological control	Biological control

Reed Canary Grass (*Phalaris arundinacea*)

Introduction

Reed canary grass invasion is usually associated with ditching of wetlands, stream channelization, and deforestation of swamp forests, sedimentation, and intentional planting. Over time, reed canary grass forms a large, monotypic stand that harbors few other plant species and are subsequently of little use to wildlife. Once established, reed canary grass dominates an area by building up a large seed bank that can eventually germinate, and re-colonize treated sites.

Description

Reed canary grass is a large, coarse grass that can reach 2 to 9 feet in height. Is has an erect, hairless stem with gradually tapering leaf blades 3 ½ to 10 inches long and ¼ to ¾ inch wide. The blades are flat and have a rough texture on both sides. The compact panicles are erect or slightly spreading and range from 3 to 16 inches long. Single flowers occur in dense clusters in May to mid-June. The grass is one of the first to sprout in spring, forming a dense rhizome system that dominates the subsurface soil.

Habitat

Reed canary grass is a cool-season, sod-forming, perennial wetland grass native to Eurasia. This variety was selected and brought to the United States in the 1800s for forage and erosion control. Reed canary grass can grow on dry soils in upland habitats and in the partial shade of woodlands, but does best on fertile, moist organic soil in full sun. This species can invade most types of wetlands, including wet prairies, fens, marshes, sedge meadows, stream banks, and seasonally wet areas. At the Albany Rapp Road Landfill Ecosystem Mitigation, Restoration and Enhancement project the biofilter wetland, sedge meadow and edges of the forested wetlands will be the most susceptible to invasion by reed canary grass. It will also grow in disturbed areas such as spoil piles.

Mechanical Control

Small, discrete patches may be covered by black plastic for at least one growing season; the bare spot can then be reseeded with native species. This method is not always effective and must be monitored because rhizomes can spread beyond the edge of the plastic.

Mowing—twice yearly (early to mid-June and early October) may help control reed canary grass by removing seed heads before the seed matures and exposing the ground to light, which promotes the

growth of native wetland species. Discing the soil in combination with a mowing or burning regime may help by opening the soil to other species. Hand-pulling or digging may work on small stands in the early stages of invasion.

Chemical Control
Chemical control using glyphosate is the recommended treatment for management. A formulation of glyphosate designed for use in wetlands will kill reed canary grass when applied to foliage. Apply in early spring when most native plant species are dormant. Any herbicide application should be done only after removing dead vegetation from previous year in order to maximize exposure and minimize herbicide use. Table 3 provides information on several New York State approved herbicides that may be effective on reed canary grass.

While herbicide treatments kill actively growing plants, the seed bank may germinate and re-colonize the site. Several herbicide applications may be necessary to inhibit seed bank re-colonization. After the first application of herbicide has killed living plants, disturbance of the soil can encourage seed bank germination. When this occurs, the site can be treated again to deplete the seed bank.

An alternative method involves wick application of glyphosate in the early to mid-June, followed by an early to mid-July burn. This technique reduces reed canary grass coverage, depletes the seed bank, and stimulates native seed banks.

Biological Control
Currently there is no biological control for reed canary grass.

Narrow-leaved Cattail (*Typha angustifolia*)

Introduction
The acreage of cattail-dominated wetlands in the United States has increased drastically since the early twentieth century due to changes in hydrology and land use. Cattails can quickly dominate a wetland plant community and produce monotypic stands that reduce the overall habitat value.

Description
The narrow-leaved cattail leaves originate at the base of the stem, 1-3 meters high, and spread outward. Below ground, starchy rhizomes anchor the plant to the soil. The flower head, shaped like an elongated cylinder, is a compact spike at the terminal end of the stem. The flower spike is divided into two readily distinguished parts: pistillate flowers form a brown club located below the yellow spire of staminate flowers.

Habitat
Narrow-leaved cattail can be found in damp soil or shallow water where sufficient nutrients are available. It is a common site along highways, in artificial ditches and shallow ponds, at the edges of calm waters, in wet patches of suburban yards, and in freshwater marshes.

Mechanical Control
The control of cattails by the manipulation of water level must be timed to the annual cycle of carbohydrate storage. Special leaf and stem cells provide air passage from both living and dead leaves to the rhizomes. Removing dead leaves and submerging the shoots in early spring will strain the plant and eventually kill it. The depth of water necessary to kill the plant depends on

temperature; the quantity of starch the plant stored the previous year, and the general vigor of the plants.

Therefore, no minimum water depth can be prescribed, but generally, a water level maintained 3-4 feet above the tops of existing spring shoots will retard growth. The use of water is most efficient if the water level is progressively raised so that all plant parts remain submerged by no more than a few inches.

Starch reserves in the rhizomes are at the minimum in late spring when the pistillate spike of the cattail is lone green and the staminate is dark green. This is the best time to employ cutting, crushing, shearing, and/or discing to eliminate cattail colonies because all these methods impede starch storage during the growing season. Cutting, crushing, shearing, or discing severs the link that provides oxygen between the rhizomes and leaves of cattails during dormancy. These techniques must be combined with high springtime water levels in order to effectively retard plant growth. Bulldozers can effectively remove plants from a marsh area, but will drastically disturb the wetland.

Chemical Control
Herbicide application to manage narrow-leaved cattail densities is the recommended method. Application in mid to late summer enhances the effectiveness of translocated herbicides, although the herbicides will have little effect on seed production during the year of application. Table 3 provides information on potential herbicides for cattail control. Water level control to minimize recruitment from the seed bank can be used to ensure cattails will not return once reduced by herbicides.

Water Chestnut (*Trapa natans*)

Introduction
Water chestnut (*Trapa natans* L.) is also known as horned water chestnut or water caltrop. Water chestnut is an aquatic weed of the northeastern United States that can dominate ponds, shallow lakes, and river margins. Water chestnut was first observed in North America, growing in Sanders Lake, Schenectady, New York. Water chestnut is also known to occur in the Mohawk River, within the Woodlawn Preserve in Schenectady, New York and within Tivoli Park in Albany, New York. The plant subsequently spread to other areas in the northeastern United States.

Description
Water chestnut is an annual herb with a floating rosette of leaves around a central stem that is rooted in the hydrosoil. The spongy inflated leaf petioles enable the rosette to float. The plant produces new leaves from a central terminal meristem in the rosette near the surface of the water. The inconspicuous flowers are born in the leaf axils of younger leaves above the water. The single-seeded mature fruit are woody and bear four sharply pointed horns. When mature, the fruits fall from the plant and sink to the bottom of the water body. A seed dormancy period of four months has been found. The horns may act as anchors to limit the movement of the seed, keeping them in suitable depths of water. The seeds overwinter at the bottom of the water body, and germinate during, and throughout much of the warm season to produce shoots that grow to the water surface, where the typical rosette is formed. Seed can remain viable for up to five years.

Habitat
Water chestnut grows best in waters that are nutrient rich and moderately alkaline. It can grow in water up to 5m deep, but prefers shallow waters (0.3 to 2.0m deep). Where abundant, up to 50 rosettes can grow in 1 m^2, which enables it to cover with water with up to three layers of leaves. Heavy shade by water chestnut suppresses both submersed and other floating plants. Water chestnut propagules are likely transported to small water bodies by waterfowl. Therefore there is a potential for invasion of water chestnut into small pond or wetland areas within the Ecosystem Mitigation Restoration and Enhancement Project. Annual monitoring of these potential areas will be conducted. The weed's extensive clonal propagation ability enables it to successfully colonize and monopolize aquatic habitats.

Mechanical Control
Because wetland areas capable of being invaded by water chestnut are being created and restored at the Albany Rapp Road Landfill Ecosystem Mitigation, Restoration and Enhancement area are small in size, smaller infestations or individual plants that are located will be removed by hand. Removal of water chestnut through mechanical methods is a recommended alternative if infestations are larger.

Chemical Control
2,4,-D is the only licensed chemical known to successfully control this species.

Biological Control
The specific geographic origins of the water chestnut genotype(s) that has become a problem in the United States are unknown. The weed usually is thought to be from Eurasia but recent work considers it of Asian origin. Some of the natural enemies occur in areas with climates similar to those of the infested areas of North America

Although water chestnut continues to be a problem that requires expensive control efforts, no biological control research is being conducted at this time, but future research could help develop biological controls for the weed.

Moneywort (*Lysimachia nummularia*)

Introduction
This plant is a native of Great Britain and much of Europe. It was first introduced as an ornamental. Although initially only widespread in the northeastern U.S., it now can be found into Canada, throughout the north-central states, and along the west coast.

Description
Moneywort is a low-growing herb with smooth stems that grow to 2 feet (61 cm) long, have a 0.05-0.1 inch (1.2-2.5 mm) diameter, and branch frequently to form a mat-like growth. The leaves are simple, short-petioled, and opposite. The broadly oval leaves, which are obtuse at both ends, resemble small coins and give the plant its name. The 0.6-1 inch (17-25 mm) solitary flowers are wheel-shaped, 5-petaled, and are found in the leaf axils on a stalk as long as the leaves. The yellow flowers growing from the leaf bases are spotted with small dark red dots and bloom June to August. Fruit is a capsule that opens longitudinally to expose the many seeds inside. Moneywort should be accurately identified before attempting any control measures.

Habitat
Moneywort is most abundant in wet meadows, swamps, disturbed floodplain forests, and stream borders. It prefers moist, rich, shaded soils and is likely to be found in lawns, pastures, and along ditches and streams. Moneywort invades floodplain forests, wet and mesic prairies, marshes, and swamps. The plant tends to cover the ground with a mat of low-growing vegetation, excluding other herbaceous vegetation. Its ability to root at nodes enables it to cover larger areas.

Mechanical Control
In low wetland woods where it is invading, one method of control is by prescribed burning in spring or fall when moneywort is green but most native vegetation is dormant. The plant can be hand pulled where practical. All stems are green but most native vegetation is dormant. The plant can be pulled fro the area to prevent the stems from rooting again in the soil. Mowing is not effective sine moneywort adheres closely to the ground due to its many rooting nodes. In low-quality buffer areas, prolonged submergence will kill moneywort. It is unlikely that moneywort will require sufficient, management efforts at the Albany Pine Bush Preserve areas. The recommended method at the restoration sites with the Albany Rapp Road Landfill project, moneywort can be controlled by establishing native grasses to shade it out. Suggested grasses include *Cinna arundinacea* and *Elymus virginicus*. Seeding of native grasses should be used only at restoration sites.

Chemical Control
Herbicides such as Roundup or Rodeo may be effective control measures, but they have not been tested by many natural area managers.

Biological Control
No biological controls that are feasible in natural areas are known.

Potential Woodland Problematic Species

Oriental bittersweet (*Celastrus orbiculatus*)

Introduction
Oriental bittersweet is a vigorously growing vine that climbs over and smothers vegetation which may die from excessive shading or breakage. Many of the forested areas at the Albany Rapp Road Landfill and adjacent properties contain sizable numbers of oriental bittersweet vines. When bittersweet climbs high up on trees the increased weight can lead to uprooting and blow-over during high winds and heavy snowfalls
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Description
Oriental bittersweet reproduces prolifically be seed, which is readily dispersed to new areas by many species of birds including mockingbirds, blue jays and European starlings. The seeds germinate in late spring. It also expands vegetatively through root suckering.

Habitat
Oriental bittersweet infests forest edges, woodlands, fields, hedgerows, coastal areas and salt marsh edges, particularly those suffering some form of land disturbance. While often found in open, sunny sites, its tolerance for shade allows oriental bittersweet to invade forested areas.

Mechanical Control

Small infestations can be hand-pulled but the entire plant should be removed including all the root portions. If fruits are present, the vines should be bagged in plastic trash bags and disposed of in a landfill. For climbing vines, first cut the vines near the ground at a comfortable height to kill upper portions and relieve the tree canopy. Vines can be cut using pruning snips or pruning saw for smaller stems or a hand axe or chain saw for larger vines. Try to minimize damage to the bark of the host tree. Rooted portions will remain alive and should be pulled, repeatedly cut to the ground or treated with herbicide. Cutting without herbicide treatment will require vigilance and repeated cutting because plants will re-sprout from the base.

Chemical Control

Systemic herbicides like Garlon® 3A, Garlon® 4 and glyphosate (e.g., Accord®, Roundup®, Rodeo®) are absorbed into plant tissues and carried to the roots, killing then entire plant within about a week. The recommended management method for the Albany Rapp Road Landfill expansion is to first cut the stem by hand or mowed and herbicide is applied immediately to cut stem tissue. Herbicide applications an be made any time of year as long as temperatures are above 55 or 60 degrees F. for several days and rain is not expected for at least 24 hours. Fall and winter applications will avoid or minimize impacts to native plants and animals. Repeated treatments are likely to be needed. In areas where spring wildflowers or other native plants occur, application of herbicides should be conducted prior to their emergence, delayed until late summer or autumn, after the last killing frost occurs, or carefully targeted. Herbicidal contact with desirable plants should always be avoided. If native grasses are intermingled with the bittersweet, triclopyr should be used because it is selective for broad-leaved plants and will not harm grasses.

Basal Bark Application— Use a string trimmer or hand saw to remove some of the foliage in a band a few feet from the ground at a comfortable height. To the exposed stems, apply a 20% solution of triclopyr ester (Garlon® 4) in commercially available basal oil with a penetrant to vine stems. Avoid application of herbicide to the bark of the host tree.

Cut Stem Application— Is the recommended treatment for oriental bittersweet. Use this method in areas where vines are established within or around non-target plants or where vines have grown into the canopy. Cut each vine stem close to the ground (about 2 in. above ground) and immediately apply a 25% solution of glyphosate (e.g., Accord®) or triclopyr (e.g., Garlon® 3A) mixed with water to the cut surface of the stem. The glyphosate application is effective at temperatures as low as 40 degrees F and a subsequent foliar application may be necessary. The triclopyr application remains effective at low temperatures (<60 degrees F) as long as the ground is not frozen. A subsequent foliar application may be necessary to control new seedlings.

Foliar Application—Use this method to control extensive patches of solid bittersweet. It may be necessary to precede foliar applications with stump treatments to reduce the risk of damaging non-target species. During foliar applications some of the herbicide is also absorbed through the stem for additional (basal bark) effect. Apply a 2% solution (8 oz. per 3 gal. mix) triclopyr ester (Garlon® 4) or triclopyr amine (Garlon® 3A) mixed in water with a non-ionic surfactant to the leaves. Thoroughly wet the foliage but not to the point of runoff. The ideal time to spray is after much of the native vegetation has become dormant (October-November) to avoid affecting non-target species. A 0.5% concentration of a non-ionic surfactant is recommended in order to penetrate leaf cuticle. If the 2% rate is not effective try an increased rate of 3-5%. Ambient air temperature should be above 65 degrees F.

For dense, low patches of bittersweet another alternative is to cut the entire patch to the ground early in the growing season. About one month later, apply 1-2% solution of triclopyr ester (Garlon 4) or triclopyr salt (Garlon 3A) in water to the previously cut patch using a backpack spray. This method has resulted in complete root kill of the bittersweet and no off-target damage or root uptake by adjacent plants.

Biological
No biological controls are currently available for this plant.

Honeysuckles (*Lonicera species*)

Introduction
The widespread distributions of bush honeysuckles are aided by birds, which consume the ripened fruit in summer and disperse the seeds over long distances. Seedlings establish in sparse vegetation, and are usually found growing under tall shrubs and trees.

Description
Honeysuckles are arching shrubs or twining vines, native to Eurasia. The leaves are opposite, simple oval, 1-10 centimeters long; most are deciduous but some are evergreen. Many of the species have sweet-scented, bell-shaped flowers that produce sweet, edible nectar that attracts hummingbirds. The fruit is a red, blue or black berry containing several seeds. In most species, the berries are mildly toxic.

Habitat
Honeysuckles can live in a broad range of habitats with varying moisture and shade levels. Most natural communities are susceptible to invasion by one or more of the species, with or without previous invasion. Woodlands are most affected, and are more vulnerable to invasion if disturbance occurs. Other habitats at risk for invasion include forest edges, roadsides, pastures, and abandoned fields. They can also be found in bogs, fens, and along lakeshores.

Mechanical Control
Since honeysuckle roots are fairly shallow, small- to medium-sized plants can often be dug or pulled. Plants are particularly easy to remove in spring when the soil is moist. A shovel or hoe will often loosen the roots enough to allow a fairly large plant to be pulled. In sensitive areas, they type of physical removal may disturb the soil and lead to more invasions, in which case it should be avoided. Soil should be tamped down to discourage further establishment of seedlings.

Chemical Control
Honeysuckles can be controlled by cutting the stems at the base with brush-cutters, chain saws or other tools. The recommended method to manage honeysuckle shrubs is to cut the stems and apply an approved herbicide. After cutting, stumps should be treated immediately with glyphosate using a backpack sprayer or wick applicator. Other New York State approved herbicide applications may also be appropriate (Table 3). Two cuts per year are recommended; one in early spring followed by one in early fall. Stumps must be treated with herbicide following cutting or vigorous re-sprouting will occur. Follow up treatments will be required.

Biological Control
Currently there is no biological control for the non-native bush honeysuckles.

Common Buckthorn (*Rhamnus cathartica*)

Introduction
Once established, buckthorn has the potential to spread very aggressively in large numbers because it thrives in habitats ranging from full sun to shaded understory. Buckthorn species, most notably the common buckthorn and glossy buckthorn (*Rhamnus frangula*) cast a dense shade as they mature into tall shrubs. This shading has a particularly destructive effect on herbaceous and low shrub communities, and may prevent the establishment of tree seedlings.

Description
Common buckthorn is a tall shrub or small tree reaching 20 – 25 feet in height and 10 inches in diameter. Commonly this species grows into a large shrub form, having few to several stems from the base. The shrubs have spreading, loosely branched crowns. Their bark is gray to brown with prominent, often elongate, lighter-colored lenticels. Common buckthorn has dull green, ovate-elliptic leaves which are smooth on both surfaces and have minute teeth on the margins. They vary from round to pointed on the tip. Twigs of the common buckthorn often end in thorns.

Habitat
Common buckthorn originated in Eurasia and was introduced to North America as an ornamental species. It is a problem species in the understory of woodlands, in prairies, and in savannas. It also occurs in thickets, hedgerows, pastures, abandoned fields, roadsides, and on rocky sites. It aggressively competes with local flora, mainly on well-drained soils.

Mechanical Control
Small patches of plants with up to 0.4 inch diameter stems can be pulled when the soil is moist. Larger seedlings can be dug or pulled using a weed wrench. Disturbed soil will result from these techniques, and should be tamped down to minimize seeding. Girding or cutting stems between December and March may not be very effective unless followed by an application of herbicide.

Chemical Control
A combination of chemical control and cutting stems is the recommended treatment. Chemical control methods are best performed during the fall when natives are dormant, yet buckthorn is still actively growing. This lessens the risk of affecting non-target plants. Winter application of chemicals is recommended, and further lessons the risk of damaging non-target species. Table 3 provides a list of New York State approved herbicides routinely used to control non-native buckthorns.

During the growing season, cutting stems off near ground level and treating the cut stems with glyphosate successfully curbs sprouting. Cutting and herbicide application during the hottest summer months is not recommended as some chemicals volatize at higher summer temperatures. Immediately after cutting, herbicide should be applied to the stump. Re-sprouts should be cut and treated again, or sprayed with a foliar application of herbicide such as Garlon 3A. Basal bark application of a Garlon solution also effectively controls buckthorn.

Garlic mustard (*Alliaria petiolata*)

Introduction
Garlic mustard poses a severe threat to native plants and animals in forest communities in much of the eastern and Midwestern U.S. Many native wildflowers that complete their life cycles in the spring time occur in the same habitat as garlic mustard. Once introduced to an area, garlic mustard out-competes native plants by aggressively monopolizing light, moisture, nutrients, soil and space.

A single plant can produce thousands of seeds, which scatter as much as several meters from the parent plant. Water may transport seeds of garlic mustard, but they do not float well and are probably not carried far by wind. Long distance dispersal is most likely aided by human activities and wildlife. Additionally, because white-tailed deer prefer native plants to garlic mustard, large deer populations may help to expand it by removing competing native plants and exposing the soil and seedbed through trampling. Garlic mustard was first recorded in the United States about 1868, from Long Island, New York.

Description
Garlic mustard is a cool season biennial herb with stalked, triangular to heart-shaped, coarsely toothed leaves that give off an odor of garlic when crushed. First-year plants appear as a rosette of green leaves close to the ground. Rosettes remain green through the winter and develop into mature flowering plants the following spring. Flowering plants of garlic mustard reach from 2 to 3-1/12 feet in height and produce button-like clusters of small white flowers, each with four petals in the shape of a cross.

Beginning in May in the mid-Atlantic Coast Plain region, seeds are produced in erect, slender pods and become shiny black when mature. By late June, when most garlic mustard plants have died, they can be recognized only by the erect stalks of dry, pale brown seedpods that remain, and may hold viable seed, through the summer.

Habitat
Garlic mustard frequently occurs in moist, shaded soil of river floodplains, forests, and road sides, edges of woods and trails edges and forest openings. Disturbed areas are most susceptible to rapid invasion and dominance. Though invasive under a wide range of light and soil conditions, garlic mustard is associated with calcareous soils and does not tolerate high acidity.

Mechanical Control
Seeds of garlic remain viable in the soil for five years or more and effective management requires a long term commitment. The major goal is to prevent seed production until the stored seed bank is exhausted. Hand removal of plants is recommended for light infestations and when desirable native species co-occur. Care must be taken to remove the plant with its entire root system because new plants can sprout from root fragments. This is best achieved when the soil is moist, by grasping low and tugging gently until the main root loosens from the soil and the entire plant pulls out. Pulled plants should be removed from site if at all possible, especially if flowers are present.

For larger infestations or when hand-pulling is not practical, flowering stems can be cut at ground level or within several inches of the ground, to prevent seed production. If stems are cut too high, the plant may produce additional flowers at leaf axils. Once seedpods are present, but before the seeds have matured or scattered, the stalks can be clipped, bagged and removed from the site to help prevent continued buildup of seed stores.

Prescribed Burning
Fire has been used to control garlic mustard in some large natural settings but, because burning opens the understory, it an encourage germination of stored seeds and promote growth of emerging garlic mustard seedlings. For this reason, burns must be conducted for three to five consecutive years to ensure that seed bank of garlic mustard has been exhausted. Prescribed burning, used with hand pulling and/or chemical control (glyphosate) can be effective.

Chemical Control
For heavy infestations, such as monotypic stands of garlic mustard, where the risk to desirable plant species is minimal, application of the systemic herbicide glyphosate (e.g., Roundup®) is recommended. Herbicide may be applied at any time of year, including winter (to kill overwintering rosettes), as long as the temperature is above 50 degrees F. and rain is not expected for about 8 hours. Extreme care must be taken not to get glyphosate on desirable plants as the product is non-select and will kill almost any plant it contacts. Spray shields may be used to better direct herbicide and limit non-intentional drift.

Biological Control
Researchers are investigating potential biological control agents for garlic mustard which may greatly improve the control of this insidious weed. Currently no approved biological control exists for garlic mustard.

Japanese Barberry (*Berberis thunbergii*)

Introduction
Japanese barberry forms dense stands in a wide range of natural habitats. The plant alters soil pH, nitrogen levels, and biological activity in the soil. Barberry displaces native plants and reduces wildlife habitat and forage. White-tailed deer apparently avoid browsing barberry, preferring to feed on native plants, giving barberry a competitive advantage.

Japanese barberry spreads by seed and by vegetative expansion. Barberry produces large numbers of seeds which have a high germination rate. Barberry seed is transported to new locations with the help of birds and small mammals. Vegetative spread is through branches touching the ground that can root to form new plants and root fragments remaining in the soil that can sprout to form new plants.

Description
Japanese barberry is a dense, deciduous, spiny shrub that grows 2 to 8 feet in height. Branches are brown, deeply grooved, somewhat zig-zag and bear a single, sharp spine at each node. The leaves are small, oval to spatula-shaped, green, bluish-green, or dark reddish purple. Flowering occurs from mid-April to May in the northeastern U.S. Pale yellow flowers hang in umbrella-shaped clusters of 2-4 flowers each, along the length of the stem. The fruits are bright red berries about 1/3 inch long that are born on a narrow petiole. Fruits mature during late summer and fall and can persist throughout the winter.

Habitat
Barberry is shade tolerant, drought resistant, and adaptable to a variety of open and wooded habitats, wetlands and disturbed areas. It prefers to grow in full sun to part shade but will flower

and fruit even in heavy shade. It is native to Japan, but has been reported in twenty states in the Midwest and Northwest. Upland dry prairies Pitch pine scrub oak barrens restoration is the most likely areas where Japanese barberry may become problematic at the Albany Rapp Road Landfill Ecosystem Mitigation Restoration and Enhancement Project.

Mechanical Control
Prevention of seed production should be a management priority. Because barberry can re-sprout from root fragments remaining in soil, thorough removal of root portions is also important. Manual control works well but may need to be combined with chemical in large or persistent infestation.

Small plants can be pulled by hand in early spring, using thick gloves to avoid injury from the spines. The root system is shallow making it easy to pull plants from the ground, and it is important to get the entire root system. The key is to pull when the soil is damp and loose. Young plants can be dug up individually using a hoe or shovel.

Mechanical removal using a hoe or Weed Wrench® can be very effective and may pose the least threat to non-target species and the general environment at the site. Tools like the Weed Wrench® are helpful for uprooting larger or older shrubs. Shrubs can also be mowed or repeatedly cut.

Chemical Control
Treatments using the systemic herbicides glyphosate (e.g., Roundup®) and triclopyr (e.g., Garlon) have been effective in managing Japanese barberry infestations that are too large for hand pulling. For whole plant treatment, apply a 2% solution of glyphosate mixed with water and a surfactant. This non-selective herbicide should be used with care to avoid impacting non-target native plants. Application early in the season before native vegetation has matured may minimize non-target impacts. However, application in late summer during fruiting may be most effective. Triclopyr or glyphosate may be used on cut stumps or as a basal bark application in a 25% solution with water, covering the outer 20% of the stump.

Biological Control
No biological control organisms are available for this plant.

Creeping Charlie (*Glechoma hederacea*)

Introduction
Creeping Charlie forms extensive mono-specific stands of up to 33% cover. This plant is toxic to many vertebrates, although palatable to numerous insects. Creeping Charlie is insect-pollinated (by bumblebees, honey bees, beetles and ants). Studies suggest strong allelopathic effects of Creeping Charlie on other species.

Creeping Charlie spreads primarily vegetatively; establishment from seed is probably rare in many habitats. Relatively few seeds are produced per plant. Colonization by ground ivy likely follows openings created by plant mortality or disturbances caused by grazing animals. Seeds may be dispersed by ants. The germination of seeds increases after dry storage for at least one month at 68 degrees F. This species requires light for germination.

In North America its range extends throughout the United States; it is naturalized in Canada and ranges from Newfoundland to British Columbia.

Description
Creeping Charlie is a perennial, evergreen and aromatic plant in the mint family. Plants can reach a height of 1 foot. Leaves are opposite, heart-shaped, 0.8 – 1.2 inches wide, petiolate and scalloped. Flowering occurs March to July, when tubular lavender flowers appear on the axils of the leaves. Flowers are typically 0.4 inches long and come in clusters of two or more. Creeping Charlie is native to Eurasia, and was introduced in the 1800s as an ornamental or medicinal plant.

Habitat
Creeping Charlie grows on shaded roadsides, waste areas, edges of pastures, arable fields, grasslands, cleared woodlands, and shrub lands. Although it is generally absent from aquatic habitats, it is occasionally found on river banks and floodplains. Once it is established, the plant is difficult to control. While present at the Albany Rapp Road Landfill Project, creeping Charlie currently is not a problematic species and it is anticipated that little, if any, effort to control this species will be required. It is impossible to dig out and remove all root and stolon fragments.

Mechanical and Chemical Control
Small patches can be pulled or dug out damp soil. Remove all roots.

Glyphosate can be used in monotypic areas. All leaves should be well covered. Fall applications of fertilizer containing 2,4-D in lawn areas may be effective. Spot applicators of 2,4-D in combination with dicamba and mecoprop (MACPP) can be used when flowering or after the first hard fall frost. General use herbicide in weed and feed lawn fertilizers can be effective. Broadleaf control used in coordination with other herbicides (slightly toxic).

Biological Control
Currently there is no biological control for Creeping Charlie.

Potential Prairie Problematic Species

Knapweed (*Centaurea species.*)

Introduction
Several knapweed species may become a problem in the Albany Rapp Road Landfill Ecosystem Mitigation, Restoration and Enhancement Project. These weeds are a prolific seed producers with 1,000 or more seeds per plant. Seed remains viable in the soil five years or more, so infestations may occur a number of years after vegetative plants have been eliminated. The plants release a toxin that reduces growth of forage species. People are the major cause of spotted knapweed spread. These species are spread readily in hay and on vehicle undercarriages. Exercise caution when purchasing hay from known infested areas in neighboring states and provinces. These species are most likely the most potential problematic species in the Albany Pine Bush Preserve prairies and oak barrens proposed for restoration at the Albany Rapp Road Landfill Project.

Description
Spotted knapweed (*Centaurea maculosa*) generally is a short-lived perennial, reproducing solely by seeds. Seeds are brownish, less than ¼ inch long, notched on one side of the base, with a short tuft of bristles at the tip. The seeds may germinate from spring through early fall. Seedlings emerging in the fall often overwinter as a rosette of leaves, resuming growth again in the spring. The plant grows

2 to 4 feet tall and bears alternate, pale green leaves which are 1 to 3 inches long. Leaf margins of the lower leaves are divided and smooth while the surface of the leaf is rough. The upper leaves are linear in shape. Stems are erect and rough, with slender branches. Numerous flowers are produced from early July through August. Flowers are pink to light purple and are borne on tips of terminal or axillary stems. The flower petals are surrounded by stiff, black-tipped bracts, giving the flower head a spotted appearance.

Habitat
Spotted knapweed is an aggressive, introduced weed species that rapidly invades pasture, rangeland fallow land, prairies and savannas/oak barrens.

Mechanical Control
Early detection and removal of colonizing knapweed plants is vital for easy control or elimination.. Outlying plants should be controlled before main populations. Small infestations can be removed by digging or pulling when the soil is moist.

CAUTION: Some individuals experience skin reactions following knapweed exposure. Wear proper clothing (gloves, long pants and sleeves, etc.) when handling this species.

Hand pulling of small populations or individuals is the recommended method of control early on in the restoration areas. The entire root should be removed to prevent re-sprouting. Pulling is easiest on sandy soils after stems emerge and are big enough to grasp. Flowering plants should be bagged, removed from the site, and properly disposed of to make sure that seeds do not mature. Attempting to pull plants in the rosette stage, often results in breaking the plant off at the crown, unless roots are loosened with a hand trowel or small shovel. A disadvantage of pulling is that it may bring more seeds to the soil surface and result in more germination. Revisiting the site for several years to eliminate new plants is essential.

Prescribed Burning—annual burns have reduced knapweed populations from 5 to 90 percent. Reductions seem to be related to the intensity of the burn, which is dependent on the amount of grasses and sedges present. Burns that remove nearly all the duff are most effective at killing knapweed roots and normally succeed only in newly infested areas. Before using an intense burn, consider its impact on native plants in the area. If burns have effectively reduced most of the population, remove any remaining plants by pulling and digging. Reseed burned areas with native species, if they fail to reemerge.

Mowing—at the start of flowering can help limit seed production. Mowing later may spread viable seeds.

Plowing—may kill the current knapweed populations and other existing vegetation, but new knapweed plants will undoubtedly emerge from the seedbank.

Grazing—by sheep and goats may decrease knapweed seed production for that year but will likely damage other vegetation.

Chemical Control
The best spotted knapweed control is prevention. The plant generally is easy to control with herbicides but an area must be monitored for several years and retreated as necessary for seedling control.

Picloram (Gordon) at 0.25 to 0.5 pounds per acre will control knapweed plants and seedlings for two to three years. The residual control period may be shorter on gravel soils, in wet areas, and where soil organic matter is high. The optimum application time is when the plant is in the rosette growth stage in the fall or in the bud to bloom stage in the spring. Do not use picloram near water or where a sandy porous surface and substrata overlie ground water 10 feet or less below the surface. Do not allow picloram spray to fall onto surface water, banks or bottoms of irrigation ditches, streams or rivers. Consult label for grazing restrictions.

Picloram, dicamba, or clopyralid + 2,4-D (Curtail) can be used to control small infestations. Picloram and dicamba are expensive treatments, especially if knapweed infests a large area. Additional information on the use of chemicals is provided in Appendix B.

Biological control
No biological control is currently available for knapweed.

Thistle (*Cirsium species*)

Introduction
Thistles can greatly reduce species diversity in old fields, disturbed natural areas, and areas under restoration. It is best to control all non-native thistle species prior to restoration work. Canada thistle *(Cirsium arvense),* a perennial thistle is the species that is of concern at the Albany Rapp Road landfill mitigation site.

Mechanical Control
Eliminating seed production is the most effective mechanical control technique. Thistles mowed in bud or early bloom stage will produce new branches from buds in the axils of the basal leaves. However, close mowing or cutting twice per season will usually prevent seed production. Mowing once flowering has begun may result in the spread of viable seeds with the mower. For light to moderate infestations, repeat pulling, hand-cutting or mowing with a brush cutter is also an option. Plants should be pulled or cut at least three times during the growing season.

Chemical Control
Chemical control is most effective when plants are in the rosette stage and least effective when thistles are flowering. Spot application of 2,4-D, Arsenal, and Triclopyr (Garlon 3A & 4) using a wick applicator or hand sprayer can control individual stems (Table 3). Infested lands that are not considered high quality natural areas may be controlled using a foliar application of glyphosate in spring when plants are 6-10 inches tall.

Biological Control
Two exotic weevils, the flower head weevil (*Rhinocyllus conicus*) and the rosette weevil (*Trichosirocalus horridus*) have been introduced in several states, and appear to be effective biological control agents that limit populations of certain thistle species. However, these insects are not to be used in areas where populations of native thistles exist. For Canada thistle, another weevil (*Ceutorhynchus litura*) that feeds on leaf and stem tissue has been found as an effective biological control agent.

Sweet Clover (*Melilotus species*)

Introduction
Sweet clovers are fire-influenced, aggressive, weedy plants that produce populations with high rates of fluctuation. Both species (white and yellow) degrade native grasslands by overtopping and shading native sun-loving species.

Description
Yellow and white sweet clovers appear very similar except for the flower colors. Yellow sweet clover blooms earlier and is typically smaller than white sweet clover and blooms earlier. Sweet clovers are a biennial plant, which are vegetative the first year, and have a small branched stem with clover-like leaves. Leaves are divided into three finely toothed leaflets, with the middle leaflet occurring on a distinct stalk. The second year, plants appear more bush-like and can grow 3 to 5 feet tall. The flowers are densely packed on the upper four inches of an elongated stem.

Habitat
White and yellow sweet clover is found in all fifty states. Sweet clovers grow well in direct sunlight or partial shade. Neither species can tolerate dense shade. Sweet clovers are found more frequently in calcareous or loamy soils, and are most frequently found in open, disturbed, upland habitats such as savannas, prairies, and dunes.

Mechanical Control
Small amounts of sweet clover can be controlled by hand-pulling in late fall after first-year plant root crown buds have developed, or in May or June before second-year plants flower. Pulling is easier when the soil is wet. Plants can also be cut to ground level with loppers. If hand-pulling is done too early, many plants may be missed, and those with succulent stems may break off and re-sprout. But pulling must be done before seed set, otherwise cut plants will have to be removed from natural areas. For more densely populated areas, cutting with a brush saw is effective. The stand should be cut just before flowering, and checked a week later for missed or partially cut individuals.

Chemical Control
Spot foliar herbicide application to plants can be effective. Glyphosate is the preferred herbicide.

Biological Control
The native sweet-clover weevil (*Sitona cylindricollis* Fahraeus), in high concentrations, can help control white and yellow sweet clover. Unfortunately, it is not a reliable control method at this time.

Black Swallow-wort (*Cynanchum louiseae;* syn. *Vincetoxicum nigrum*)

Introduction
Eradication of black swallow-wart is difficult once a colony is established due to the dense, knobby mass of underground roots. Initial control efforts should concentrate on plants in sunny areas since they produce the largest quantity of viable seeds.

Mechanical Control
Hand pulling must be accompanied by digging up root crowns as well. The stems tend to break easily above the root crown if pulled while the root crown itself is held in place by the fibrous root system and has buds which can readily re-sprout if the stems are cut or broken. If the root crown is

pulled up, it must be removed from site and properly disposed because broken root crowns on the ground have been observed to re-grow. Mowing presents the same rapid re-sprouting problem as manual pulling alone. Fruits of the black swallow-wort can be manually removed and carried off-site to prevent seed dispersal, but this practice is time consuming and must be continued until no pods are produced and the plants have reached the end of the growing season. It is more effective to remove the entire plant by mowing or hand-pulling.

Chemical Control
The response of black swallow-wort to herbicides varies by site and site conditions. Herbicide choice for foliar spray treatments will depend on site conditions. In degraded patches with little desirable vegetation, glyphosate may be preferred. At sites with desirable grasses that should be conserved, triclopyr is the recommended herbicide.

Biological Control
Black swallow-wort appears to have few pests, disease or other natural controls in North America.

Multiflora Rose (*Rosa Multiflora*)

Introduction
Multiflora rose was originally introduced to the East Coast from Japan in 1886 as rootstock for cultivated roses. In the 1930's the U.S. Soil Conservation Service advocated use of multiflora rose in soil erosion control. Many state conservation departments have distributed rooted cuttings to landowners. It was planted in the Midwest for living fences and soil conservation. Managers recognized that plantings of this thorny, bushy shrub provided excellent escape cover and a source of winter food for wildlife

Description
Multiflora rose is a medium height, thorny, bushy shrub with a more spreading than erect growth form. Leaves are born alternately on the stems and divided into 5-11 leaflets (usually 7-9). Each leaflet is broadly oval and toothed along its margin. Numerous white flowers, three-quarter to one and one-half inch across form into clusters that bloom in late spring. The fruits are small, firm, red hips that may remain on the plant well into winter. Older rose shrubs may obtain a height of 15 feet or more with a root crown diameter of 8 inches.

Multiflora rose is named for the clusters of many white flowers born on this perennial bramble during May or June. The flowers develop into small, hard fruits called hips that remain on the plant throughout winter. The great majority of plants develop from seeds remaining in the soil relatively close to plants from which they were produced. Birds and mammals also consume the hips and can disperse them greater distances. Rose seeds may remain viable in the soil for 10-20 years. Multiflora rose also spreads by layering, i.e., where tips of canes touch the ground and form roots, and by plants that arise from shallow roots.

Habitat
Multiflora rose occurs in successional fields, pastures, and roadsides. Multiflora rose readily invades prairies, savannas, open woodland, and forest edges. It is a thorny, bushy shrub that can form impenetrable thickets or "living fences" and smother out other vegetation. It is a serious pest species throughout the eastern United States. It also may occur in dense forests, particularly near

natural disturbances such as tree fall gaps and along stream banks. It has a wide tolerance for soil, moisture, and light conditions; but it does not grow well in standing water.

Mechanical Control
Pulling, grubbing, or removing individual plants from the soil can only be effective when all roots are removed or when plants that develop subsequently from severed roots are destroyed. These approaches are most practical for light, scattered infestations. Research indicates that 3-6 cuttings or mowings per growing season for more than one year can achieve high plant mortality. Such treatment may need to be repeated for 2-4 years. Increased mowing rates (+6 per season) did not increase plant mortality. In high quality communities, repeated cutting is preferred over mowing, because repeated mowing will damage native vegetation as well as multiflora rose.

Prescribed Burning
In fire-adapted communities, at both the Albany Pine Bush Preserve and the Albany Rapp Road Landfill Ecosystem, Mitigation, Restoration and Enhancement Project, a routine prescribed burn program is recommended as the method of management and will hinder invasion and establishment of multiflora rose.

Chemical Control
Cutting stems and either painting herbicide on the stump with a sponge applicator or spraying herbicide on the stump with a low pressure hand-held sprayer kills root systems and prevents re-sprouting. Roundup herbicide (a formulation of glyphosate) has been effective in controlling multiflora rose when used as a 10-20% solution and applied directly to the cut stump. Although the Roundup label recommends a higher concentration for cut-stump treatment (50-100%), this lower concentration has proven effective. With this technique, herbicide is applied specifically to the target plant, reducing the possibilities of damaging nearby, and desirable vegetation. Cut-stump treatment is effective lat in the growing season (July-September), and also during the dormant season. Dormant season application is preferred because it will minimize potential harm to non-target species. Glyphosate is a non-selective herbicide, so care should be taken to avoid contacting non-target species, and the use of glyphosate is generally not recommended for control of multiflora rose. Both glyphosate and picloram are recommended for controlling established plants.

In addition, Triclopyr (trade name Garlon 3A) can be applied to cut stems or canes for selective control of multiflora rose. Garlon 3A diluted in water at a rate of 50% can be sprayed, using a hand sprayer, to the cut surface. Application should be within minutes of cutting. Use of Garlon3A is best done in the dormant season to lessen damage to non-target species. Great care should be exercised to avoid getting any of the herbicided on the ground near the target plant since some non-target species may be harmed. Avoid using Triclopyr if rain is forecast for the following 1-4 days; otherwise runoff will harm non-target species.

Dicamba (trade name Banvel) is an effective foliar spray that is less preferred than Krenite. Banvel is selective against broadleaf plants, so care must be taken to avoid contacting desirable, broadleaf vegetation. It can be applied as a foliar spray in a 1% solution (1 ounce of Banvel per gallon water). Though this solution can be applied any time during the growing season, best results are obtained during May and June when plants are actively growing and flowering, following, following full leaf-out. One-half ounce of a surfactant should be added when treating dense foliage and, to enhance control in late season applications, complete coverage of all green leaves should be achieved. Foliar spray of herbicides should only be used in less sensitive areas because of problems with contacting non-target species.

Biological Control

No effective biological controls that are currently considered feasible in natural communities are known. Rose rosette disease (RRD) is a fatal disease of multiflora rose and some cultivated roses, first described in the 1940s. The disease is caused by a virus-like particle transmitted by an eriophyid mite (*Phyllocoptes fructiphilus K.*). During past drought years, mite populations built up and RRD spread through much of the Midwest. The disease kills infected roses within two to three years and has already reduced weed populations in some areas. Pruning of multiflora rose will encourage succulent growth, which is more susceptible to mite infestation. Pruning may be practical in areas where RRD is present to encourage the spread of the disease. However, RRD may also infect native roses and plums, as well as commercially important plants in the rose family such as apples, some types of berries, and ornamental roses.

The rose seed chalid (*Megastigmu aculeastus* var. *nigroflavus*), a small wasp-like insect, imported from Japan, attacks developing seed of several rose species. By destroying large amounts of seed, the chalid limits new infestations. Research on the impact on cultivated roses along with studies on environmental limitations, are currently being conducted. Once more is known about the biology of these two control agents, RRD and the rose seed chalid could provide effective control of multiflora rose in areas where other methods are not feasible or are undesirable. Vulnerable to defoliation by Japanese beetles MR contains a substance (Geraniol) that attracts Japanese beetles.

Russian-Olive (*Elaegnus angustifolia*)

Introduction

Russian-olive thrives under extreme environmental conditions (e.g., temperature, moisture, soils) and has been widely adopted as a hardy tree for landscapes and windbreaks. However, Russian-olive has also demonstrated the ability to escape cultivation and become a difficult-to-control weed. Russian-olive is native to Eastern Europe and western Asia. The species arrived in the United States during colonial times and moved west with the early settlers.

Description

Russian-olive's fast-growing, deciduous shrub or small tree that usually reaches 10 to 25 feet in height. Russian-olive forms a dense thicket when a number of plants are growing close together. Leaves are arranged alternately, 2 to 3 inches in length, lanceolate with smooth margins. The upper leaf surface is green-gray while the lower surface and leaf stalks are silvery-gray. Foliage has an overall silvery appearance from tiny scales that cover the leaves. Branches are dark reddish-brown in color and usually have 1 to 2-inch woody thorns. Similar to the leaves, twigs are covered with scales that give a silvery-gray appearance. Flowers usually appear between May and June, and are yellow, bell-shaped, and arranged in clusters. Fruits are shaped like small olives and contain a single seed. Newly-formed fruits are silver but become tan or brown as they mature. Roots are deep and well-developed. Re-growth from crown or underground lateral roots is common in cut trees.

Habitat

Russian-olive thrives under a wide range of soil and moisture conditions. The plant readily survives periodic flooding and is drought tolerant. Russian-olive grows in many types of soil (e.g., sandy, silty, loamy), including sites with low fertility and high salinity.

Mechanical Control
Once established, control of Russian-olive is difficult. Live seeds persist in the soil for many years and disturbed plants can re-grow from lateral roots and other plant parts. The most effective and least expensive control tactic is to prevent establishment. Not using Russian-olive as a landscape or ornamental tree prevents it from escaping into adjacent areas where it is not wanted. When new infestations of Russian-olive emerge, immediate application of control measures usually eradicates the stand before it can develop an extensive root system and persistent seedbank.

Several mechanical management practices are effective for controlling established stands of Russian-olive. Young plants/seedlings can be hand pulled in early spring when ground is moist. It is essential to get the entire root system when hand pulling. Saplings can be trimmed with a tractor-mounted mower, but must be regularly repeated. Mowing is a relatively simple operation and the results occur quickly. For large trees, top-growth can be removed with a chain saw. Russian-olive can re-sprout from cut stumps, twigs or branches. Cut material must be removed and destroyed. New sprouts that emerge from the cut stump or lateral roots should be regularly pruned.

Chemical Control
A number of herbicides and application techniques can be used to control Russian-olive. Cut-stump applications (herbicide applied to the stumps surface immediately after removing top-growth) are often successful. Effective herbicides contain triclopyr ester (Remedy®, Garlon® 4), triclopyr (Garlon® 3A), or imazapyr (Arsenal®, Habitat®). Triclopyr ester (a.i., 12.5%) with a penetrating oil, or 2,4-D + triclopyr (Crossbow®) can be applied as basal-bark treatments (herbicide applications made directly to the lower 2 feet of an uncut Russian-olive trunk). Additional information on chemical control is found in Appendix B.

Once mature plants are controlled, competition from desired plants is needed to suppress the re-establishment of Russian-olive. Establishing native plants, such as willow and cottonwood, can reduce the resources (i.e., light, water, and nutrients) available to Russian-olive and, thereby, suppress its establishment. Perennial understory species are also important competitors with new Russian-olive seedlings. Failure to establish adequate desirable vegetation allows Russian-olive and other weeds to rapidly re-invade the site.

No single control method or one-pass effort will successfully eliminate Russian-olive. The use of two or more control methods (integrated weed management) is recommended for several years. Permanent control will require many years of monitoring and treatment until the persistent seedbank has been exhausted and all buds on the root system have been completely killed.

Smooth Brome (*Bromus inermis*)

Introduction
Smooth brome (*Bromus inermis*) is a cool season, highly competitive, exotic grass that is especially troublesome in disturbed portions of old pastures in the tall grass and mixed prairie regions. Although less invasive than some other cool season non-native grasses, it is less responsive to management techniques.

Mechanical Control
Management experience indicates that cutting smooth brome while the flowering head is still enclosed within the sheath is perhaps the most effective means of control. The best conditions for

damage are hot, moist weather at the time of cutting, followed by a dry period. The recommended management includes a lawn mowing of brome in late May and mowing at least 4 times during the season where brome patches are monotypic. Fire does not appear as effective in reducing smooth brome as some other non-native species.

Chemical Control
Several New York State approved herbicides such as glyphosate (i.e. Roundup), can be effectively applied to dense populations in April or May. Imazapyr (Arsenal) has also been approved for control in New York. Table 3 provides potential herbicides that are New York State approved. However, most herbicides are not specific to the plant, and care must be taken to avoid non-target species.

Biological Control
Currently, there are no biological control agents for use on smooth brome.

Brambles (*Rubus* species)

Introduction
A number of native and introduced species of blackberries grow in the U.S. Wildlife and people eat berries produced by several species of brambles. However, vine growth can create problems where it grows vigorously, producing mounded thickets on pastures, Christmas trees plantations, ditches, and elsewhere.

Description
Rubus is a large genus of flowering plants in the family Rosaceae. Raspberries, blackberries, and dewberries are common, widely distributed members of the genus. Most of these plants have woody stems with thorns, spines, bristles, or hairs. The fruit is an aggregate drupelet. Blackberries, as well as other species, have mounding or rambling growth habitats. Raspberries, however, have an upright cane.

Habitat
Bramble habitat includes moist to slightly dry prairie edges along woodlands, thickets, open woodlands, savannas, woodland meadows, and fence rows, areas along roadsides and railroads, and abandoned pastures. This species prefers disturbed, burned-over areas in and around woodlands. It is a common invader of prairies.

Mechanical Control
Blackberry canes (stems) grow from underground burl-like root crowns. Where berry plants are few in number, they can be killed by grubbing out the burls with a mattock. Larger infestations away from fences or ditch banks can be disked out with repeated cultivations if the soil is not too wet. It may be necessary to burn out large thickets where appropriate before disking. Hand grubbing will be more effective after disking when new canes are forming. Blackberry vines are vigorous re-sprouts if the burls are not killed. Patience is required for successful control. Burning or mowing several years in a row (skipping a year may lead to their spread). Mowing followed by foliar herbicide treatment of re-sprouts triclopyr, glyphosate or metsulfuron-methyl.

Chemical Control

Complete coverage with foliar-applied herbicides of leaves, canes, and runners is necessary for maximum effectiveness. Care must be taken while applying herbicides to prevent overspray of non-target plants.

Biological Control

At this time, very little is known about biological control of brambles. Currently in Australia, blackberry rust (*Phragmidium violaceum*) is being tested in large areas of blackberry infestations. Further research is needed before this would be an acceptable control method.

SCHEDULE & MANAGEMENT GOALS

Introduction

The Albany Rapp Road Landfill restoration and management program involves the creation, restoration and enhancement of specific native plant communities (Figure 2). The period of time required to carry out the program can depend on the condition of the ecological system, the level of effort needed, and site opportunities and constraints (e.g., access, weather, biological response). Typically, following initial construction activities an intensive management period of three to four years is required to achieve site stability (stabilize soils and reduce weed competition), followed by a moderately intensive long-term management phase of four to five years to optimize native plant vigor, cover and diversity. Once these goals have been achieved for the first 10-year period, a long-term maintenance phase is initiated to maintain the restored site conditions.

A ten-year schedule of restoration and management activities to be conducted following completion of each construction phase is included in Table 1. This schedule provides a summary of tasks to be accomplished at the site. Quarters of the year are placed in Brackets to depict when the management activity should be implemented The schedule of any Integrated Pest Management program needs to be flexible because of the variability exhibited by the temporal and spatial resources addressed by the plan. Management activities and the timing of the activities may need to change in response to new data and derived insights. For these reasons, the schedule in Table 1 should be viewed as being neither conclusive nor absolute. Plans on a map need to be flexible. This schedule is a starting point in an ongoing process of restoring and managing the site's biodiversity and natural processes. Regular monitoring during the management phase that is anticipated to begin in 2010 will provide feedback on the program's effectiveness, and generate information to evaluate and justify the need for schedule changes. The Adaptive Management strategy is fundamental to the success of the restoration, management, and maintenance work proposed in the schedule.

The following goals are recommended for the 10-year period of the short and long-term management phases:

1. *Manage Forested Wetlands*
    - Remove invasive non-native woody vegetation from the forest/woodland, including common buckthorn and non-native honeysuckles. Selectively cut and remove aggressive native woody saplings such as box elder, and elm in selected locations of wet forests. This work will involve cutting and stump treating with an appropriate herbicide (Table 3) or as a basal bark herbicide application and allowing dead saplings to fall and be consumed over time by decomposition. Additionally, some shrubs may receive a foliar Garlon herbicide spray.
    - Control invasive non-native herbaceous vegetation with appropriate herbicides (Table 3), and/or other allowable management techniques, such as prescribed burning, to encourage the growth of native forest/woodland species. Buckthorns and honeysuckles are the two species of most concern in the forest areas.
    - Deer exclosures or other tree protection methods may need to be employed at the time of any tree and shrub installation.

- Emerald ash borer has not been located in this section of New York State as of 2008. If it spreads to this region of the State, appropriate steps to monitor the site will be initiated, and if found, the appropriate approved control methods outlined in Appendix A will be employed.

2. *Manage Pitch Pine/Oak Barrens/Dry Prairie Mosaic*
    - Remove invasive non-native woody vegetation from the existing pitch pine woods and oak woods and selectively cut aggressive native woody species as described in 1 above.
    - Control invasive non-native herbaceous vegetation as described in 1 above, and encourage growth of native species.
    - Deer exclosures or other tree protection methods may need to be employed at the time of savanna tree and shrub installation.
    - Develop prescribed burn plan and initiate a prescribed burn of the pitch pine/oak woods and dry prairie/sand flat areas

3. *Manage Native Wetland Herbaceous Communities*
    - Manage the restored and created wetlands by removal of exotics. This will require control of invasive non-native species through application of appropriate herbicides (Table 3), mowing, and/or other allowable management techniques.
    - Manage the wetlands that provide diverse native wildlife habitat, additional stormwater and flood management functions, as well as aesthetic and wildlife benefits.
    - Geese and mute swans are not likely to be problematic at the site. During the initial installation of wetland plants appropriate fencing or other methods of exclosures will be constructed to protect the establishment of the emergent plants in the biofilter. After the establishment phase geese numbers if present will be evaluated and if populations are deemed excessive, appropriate control methods outlined in Appendix A will be employed
    - Develop a prescribed burn plan and initiate prescribed burning as fuel loads become sufficient and weather conditions are conducive.

REFERENCES CITED

Applied Ecological Services, Inc. 2009. Albany Rapp Road Landfill Ecosystem Mitigation, Restoration & Enhancement Plan.

New York State Department of Environmental Conservation, 2004a. Part 325 Rules and Regulations: relating to the Application of Pesticides. Revised January 1, 2004.

New York State Department of Environmental Conservation, 2004b. Article 33 and Portions of Article 15 and 71 of the Environmental Conservation Law. September, 2004.

Table 1. General Ten Year Management Schedule for Albany Rapp Road Landfill.

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
1.	Weed Management and Site Inspection	1[2] [3]*4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4
Assess site condition; identify threats. Recommend mowing where necessary and design herbicide application plan.											
2.	Mowing.	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4
Conducted once or twice annually for weed control.											
3.	Herbicide Management	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]
Potential problematic plant species.											
3a.	Smooth brome	1[2]3[4]	1[2]3[4]	1[2]3[4]	1[2]3[4]	1[2]3[4]	1[2]3[4]	1[2]3[4]	1[2]3[4]	1[2]3[4]	1[2]3[4]
3b.	Thistles	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4
3c.	Black swallow-wort	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4
3d.	Honeysuckles	[1]23[4]	[1]23[4]	[1]23[4]	[1]23[4]	[1]23[4]	[1]23[4]	[1]23[4]	[1]23[4]	[1]23[4]	[1]23[4]
3e.	Purple Loosestrife	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4
3f.	Sweet clovers	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4
3g.	Reed canary grass	1[2]3[4]	1[2]3[4]	1[2]3[4]	1[2]3[4]	1[2]3[4]	1[2]3[4]	1[2]3[4]	1[2]3[4]	1[2]3[4]	1[2]3[4]
3h.	Buckthorns	[1]23[4]	[1]23[4]	[1]23[4]	[1]23[4]	[1]23[4]	[1]23[4]	[1]23[4]	[1]23[4]	[1]23[4]	[1]23[4]

*Bracketed [ ] numbers represent the quarter of the year the management activity should occur.

Table 1. General Ten Year Management Schedule for Albany Rapp Road Landfill (continued).											
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
3i.	Narrow leaf cattail	12[3]4	12[3]4	12[3]4	12[3]4	12[3]4	12[3]4	12[3]4	12[3]4	12[3]4	12[3]4
3j.	Common reed grass	12[3]4	12[3]4	12[3]4	12[3]4	12[3]4	12[3]4	12[3]4	12[3]4	12[3]4	12[3]4
3k.	Knapweed	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4
3l.	Water chestnut	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4
3m.	Garlic mustard	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]
3n.	Japanese Barberry	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4
30.	Oriental Bittersweet	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4
3p.	Russian Olive	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]
3q.	Creeping Charlie	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4
3r.	Moneywort	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4
3s.	Multiflora Rose	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]
3t.	Brambles	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4
4.	Prescribed Burn Management	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4	1[2][3]4
[ ] indicates the quarter of the year when the activity should occur.											

Table 2. Long-Term Management Activities.

Plant Community	Spot Herbicide Treatment* (events/year)	Conduct Prescribed Burning**	Remedial Seeding & Planting (As necessary)	Annual Monitoring (events/year)
Forested Wetlands	2-3	5-10	3-5***	1
Other Wetlands	2	2-3	3	1
Pitch Pine/Oak Forests	1-2	5-10	2-3	1
Dunes/Dry Prairies/Barrens	1-2	2-3	2-3	1
Sedge meadow	1-2	2-3	3-5	1
Vernal Pond	1-2	5-10	3-5	1

*Spot Herbicide Treatment and Remedial Seeding & Planting schedules assume mowing (or other allowable management techniques) will be employed as a restoration and management technique.
**If approved and permitted by state, local or federal authorities.
*** Number of year interval when activity may need to occur.

Table 3. New York State Approved Herbicides* for Potential Invasive Species Control at the Albany Rapp Road Landfill.

Commercial Name									
Commercial Name	**Cornerstone**	**Aquaneat**	**Arsenal**	**2,4-D**	**Garlon**	**Garlon 3A**	**Poast**	**Esort**	**Oust XP**
Active Ingredients									
Species	**Glyphosate**	**Aquatic Approved Glyphosate**	**Imazapyr**	**2, 4-D**	**Triclopyr**	**Aquatic Approved Triclopyr**	**Sethoxydim**	**Metsulfuron Methyl**	**SulfometusonMethyl**
Buckthorn - cut stump	50-100%	50-100%			20-30%	30-40%			
Buckthorn - basal bark					15-30%	50%-100%			
Honey Suckle - cut stump	50-100%	50-100%			20-30%	30-40%			
Honey Suckle - foliar	5%	5%			2-5%	3-6%		0.5%-1%	
Purple Loosestrife	3%	3%			2-3%	3%			
Sweet Clover	3%	3%	1%	1.5-2%					
Reed Canary Grass	2-4%, typical 2%	1.5-2.5%	1%				2-3%		1(1/3)-2 oz/ Ac
Cattails	5%	5%	2-3%						
Canada Thistle	3%	3%	2%	2%	3%	3%		0.25-0.5%	
Common Reed	5%	5%	2-3%						
Black Swallow Wort					1-3%	1-3%			
Smooth Brome	3%						2-3%		2-3 oz/ Ac
Knapweed	3%			1-2%					
Water chestnut				1-2%					

Commercial Name									
Commercial Name	**Cornerstone**	**Aquaneat**	**Arsenal**	**2,4-D**	**Garlon**	**Garlon 3A**	**Poast**	**Esort**	**Oust XP**
Active Ingredients									
Species	**Glyphosate**	**Aquatic Approved Glyphosate**	**Imazapyr**	**2, 4-D**	**Triclopyr**	**Aquatic Approved Triclopyr**	**Sethoxydim**	**Metsulfuron Methyl**	**SulfometusonMethyl**
Garlic mustard	2-3%								
Japanese Barberry	2%				2%				
Japanese Barberry – cut stump	25%					25%			
Oriental Bittersweet	2-3%				2-3%	2-3%			
Oriental Bittersweet – basal bark	25%					20%			
Russian Olive	2-3%			1-2%	2-3%				
Creeping Charlie	2-3%			1-2%					
Moneywort	2-3%	2-3%							
Multiflora Rose	1-2%								
Multiflora Rose – cut stem	10-20%					50%			
Brambles	1-2%								

* As of August 2008.

LEGEND

- Project Limit Line
- Existing Landfill 83.06 AC
- Existing Stream
- Existing Wetland
- Existing 10' Contours
- Existing 2' Contours
- Sheet Match Line

Wetlands

- Forested Wetland 15.41 AC
- Disturbed Forested Wetland 5.71 AC
- Red Maple Stand (East of T. Park) 9.16 AC (See Note 2)
- Pine Barrens Vernal Pond 0.45 AC

Wetlands

- Phragmites 20.80 AC

Upland Grassland Communities

- Pine Stand/Old Pasture 0.35 AC
- Old Field 2.57 AC
- Old Field/Scattered Cottonwoods on Spoil Piles 11.11 AC
- Dry Prairie Remnant 0.17 AC

Upland Forest Communities

- Upland Mesic Forest 18.67 AC (See Note 3)
- Pitch Pine/Scrub Oak 17.80 AC
- Disturbed Oak Pine Forest 4.09 AC
- Quaking Aspen/Dense Shrub 9.33 AC

Upland Forest Communities

- Degraded Oak/Pine Woodland 1.32 AC
- Disturbed Forest 4.84 AC
- Black Locust/ Black Cherry 3.24 AC
- Gray Birch/ Dense Shrub 0.53 AC

Upland Forest Communities

- Red Oak Dominated 10.78 AC

Developed Land

- North Powerline Easement 1.29 AC
- Powerline Corridor 1.31 AC
- Trailer Park 1.56 AC

IN PROGRESS DO NOT USE FOR CONSTRUCTION

Albany Rapp Road Landfill

Albany, New York

City of Albany, Dept. of General Services

One Connors Blvd.
Albany, New York

Existing Land Cover Plan

REVISIONS		
No: 8	Date: 01 April 2009	By: krv
Description: Revisions to 90% CD Set based on March 23rd meeting comments		
No: 9	Date: 10 April 2009	By: krv/mrr
Description: Edits to grading plan based on historic points/ markers.		
No: 10	Date: 16 April 2009	By: krv/mrr
Description: Edits to grading, restoration, wetland mitigation, stream restoration and erosion control plans.		
No: 11	Date: 28 April 2009	By: krv
Description: Edits to grading, restoration and wetland mitigation plans.		

AES Proj. #:	06-0590
Checked:	
Approved:	
Drawn by: mrr & krv	
File: 060590cnst	
Date: 10 April 2009	
Coordinate System: NAD NY State Plane, East (ft)	

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Sheet Number

Fig. 1

LEGEND

- Project Limit Line
- Sheet Match Line
- Wetland Boundary
- Trail
- Nursery
  1.44 AC

Upland Grassland Communities

- Dry Prairie/Sand Flat
  45.00 AC
- Dune
  1.92 AC
- Dune/Barren
  2.31 AC

Upland Forest Communities

- Pitch Pine-Scrub Oak Barrens
  121.78 AC
- Pitch Pine-Oak Forest Buffer Enhancement
  30.92 AC

Wetland Communities

- Biofilter Wetland
  1.42 AC (.69 AC created + .73 AC restored)
- Pine Barrens Vernal Pond
  1.47 AC (1.12 AC created + .35 AC restored)
- Sedge Meadow
  0.63 AC
- Forested Wetland (Red Maple Hardwood Swamp)
  13.48 AC (11.47 AC created + 2.0 AC restored)
- Forested Wetland Enhancement (Red Maple Hardwood Swamp)
  27.59 AC
- Forested Riparian Wetland (Red Maple Hardwood Swamp)
  7.02 AC (6.2 AC created + .73 AC restored)

N

0 100 200 400 Feet

Scale: 1" = 200'
To Scale When Printed at 24" x 36"

IN PROGRESS
DO NOT USE FOR CONSTRUCTION

Albany Rapp Road Landfill

Albany, New York

City of Albany, Dept. of General Services
One Connors Blvd.
Albany, New York

Restoration Plan

REVISIONS

No: 8	Date: 01 April 2009	By: krv
Description: Revisions to 90% CD Set based on March 23rd meeting comments		
No: 9	Date: 10 April 2009	By: krv/mr
Description: Edits to grading plan based on historic points/ markers.		
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AES Proj. #: 06-0590
Checked:
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File: 060590cnst
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Coordinate System: NAD NY State Plane, East (ft)

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Sheet Number

Fig. 2

LEGEND

- Project Boundary
- Existing 2' Contours
- Existing 10' Contours
- Proposed 2' Contours
- Proposed 10' Contours
- Existing Wetlands
- Common Reed Grass
- Knapweed
- Honeysuckle
- European buckthorn, garlic mustard and Oriental bittersweet
- Topsoil Stripping Treatment

N

0 100 200 400 Feet

Scale: 1" = 200'

To Scale When Printed at 24" x 36"

IN PROGRESS
DO NOT USE FOR CONSTRUCTION

Albany Rapp Road Landfill

Albany, New York

City of Albany, Dept. of General Services

One Connors Blvd.
Albany, New York

Invasive Plant Species

REVISIONS

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No: 11	Date: 28 April 2009	By: krv
Description: Edits to grading, restoration and wetland mitigation plans.		

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Sheet Number

Fig. 3

APPENDICES

Appendix A

Alphabetical listing of Invasive Fauna Species and Management Techniques

Emerald Ash Borer (*Agrilus planipennis*)

Introduction
The emerald ash borer (EAB) is a shiny green beetle native to Asia. Since its accidental introduction into the United States, it has spread to seven states and adjacent parts of Canada. It has killed nearly 20 million ash trees so far and threatens to decimate the ash trees throughout the United States.

Description
The average length for an adult emerald ash borer is ¾ inch long and 1/6 inch wide. The larvae are approximately 1 mm long and 15 mm in diameter, and are a creamy white color. The eggs turn a yellow to brown color prior to hatching. Adults lay eggs in crevasses in the bark. Larvae burrow into the bark after hatching and consume the cambium and phloem, effectively girdling the tree and causing death within two years. The average emerging season for the EAB is early spring to late summer. Females lay around 75 eggs, but up to 300 from early May to mid-July. The borer's life cycle is estimated to be one year in Southern Michigan but may be up to two years in colder regions.

Habitat
The natural range of the EAB is eastern Russia, northern China, Japan, and Korea.

Signs of EAB Infestation
Ash trees may have EAB for several years before any signs and symptoms are recognizable. Signs and symptoms of an infested tree include:

- Delayed leaf-out in spring (symptom)
- Thinning canopy or crown (symptom)
- Branch dieback from top of tree (symptom)
- S-shaped tunneling under the bark (sign)
- Woodpecker damage (symptom)
- Epicormic shoots/water sprouts (symptom)
- Bark splits (symptom)
- D-shaped exit holes – first spotted in upper branches (sign)

EAB Survey Methods
Visual Surveys: This technique includes looking for the outwardly visible symptoms of EAB on ash trees. Surveys can be conducted systematically over a given area or by individually selected trees through an inventory. Visual surveys are conducted by persons on the ground evaluating individual ash trees for EAB symptoms. The use of binoculars can assist in visual inspections of the upper portions of the trees. The advantages of visual surveying techniques include few resources that can cover large areas in a short amount of time. The disadvantages are that the time visual symptoms of EAB are present; it usually means the infestation has been present for several years, and protection measures may not be warranted.

Tree Climbing: The technique is employed when a closer look of the tree's canopy in warranted. Professional tree climbers should be utilized in these situations and be trained in

EAB identification. Once in the canopy of the tree, small windows of the canopy's trunk and branches can be peeled back using a small knife, to look for EAB larvae. Areas to focus on are thinning branches, bark splits, and woodpecker damage. The advantages of the tree climbing technique include close-up views of the canopy of an ash tree, the area where first symptoms appear. The disadvantages include the costs of utilizing specialized people and the time it takes to individually inspect trees.

Destructive Sampling: This technique includes the removal and/or peeling of an ash tree to look for EAB larvae and larval galleries. Ash trees are selected and removed at the base. Ash trees that are sampled can be of any size, but are the most efficient to peel when they are between 4"-12" DBH. Focus on peeling areas of the trees that include weak branches, bark cracks, epicormic shoots (An epicormic sprout is a shoot that arises from latent or adventitious buds. Also known as a water sprout, they form on stems and branches, and suckers produced from the base of trees. In older wood, epicormic shoots can result from severe defoliation or radical pruning.), or woodpecker damage. One advantage to this technique is the discovery of early infestations. This is a significant factor in determining appropriate management solutions for infested areas. A disadvantage of this technique is that once the tree is removed and peeled, it is destroyed.

Detection Trees: This technique involves artificially wounding a tree to purposefully stress it, which studies have shown will attract EAB to that particular tree. The most effective way to wound a tree enough to attract EAB is to remove a band of bark from the trunk of the ash tree, also called girdling. This will disrupt the conductive tissue within the tree, and it will no longer be able to translocate water and nutrients. Removing the bark from only a portion of the base of the tree is not as effective as completely circling the trunk. Detection trees are currently the most effective tool available for surveying EAB. Unfortunately, this method also destroys the ash tree that is used for surveying.

Control

Mechanical Control

Mechanical control once an infestation has been identified includes removal of all ash trees within a ½ mile radius of the infestation. This technique must be completed by a certified arborist and tree removal company, as to not spread the infestations further. This is the only certain method to control EAB.

Chemical Control

Insecticidal control is used at this time as a preventative to treat ash trees within 10-12 miles from known infestations. Control is more effective on smaller trees, with a trunk diameter of less than 10 inches. If many infested trees are nearby, insecticide and other control are unlikely to protect trees due to the heavy onslaught of beetles from nearby infestations. Any insecticides proposed if EAB is detected on the Albany Landfill Wetland Mitigation site will be New York State approved.

Biological Control

At this time, biological control techniques are still in the experimental stage. Further research is being conducted to find insect, fungal, or microbial bio-control methods.

Canada Geese (*Branta canadensis*)

Introduction

Canada geese are perhaps the most widely recognized birds of North America. Geese flying in a V-formation signal changes in season and for many people have come to symbolize nature and wildlife. In the early 1900s, Canada goose populations were nearly eliminated in most parts of North America by unrestricted harvesting of eggs, commercial hunting, and draining of wetland habitat. Thanks to enactment of strict harvest regulations, creation of protected refuges, changes in crop planting and harvesting techniques, and creation of large, open grassy areas, most Canada goose populations have rebounded and are no longer at risk.

Canada geese have gray-brown wings and back; light gray to dark brown sides and breasts; black tails, feet, legs, bills, and heads; and black necks with distinctive white cheek patches that usually cover parts of its throat. They also may exhibit the largest size variation of any animal species in the world; depending on the subspecies and race, body weights range from 3 to 15 pounds. Males tend to be bigger than females, and juveniles attain complete plumage three to four months after hatching.

Life Cycle

The annual life cycle for geese begins in late winter when adult pairs return to nesting areas in late February or march, as soon as water open up. Egg-laying and incubation generally extend through April, with the peak of hatching in later April or early May, depending on location. After hatching, goose families may move considerable distances from nesting areas to brood-rearing areas.

After nesting, geese undergo an annual "molt", a four-five week flightless period when they shed and re-grow their outer wing feathers. Molting begins in mid-June and late-July, and the birds resume flight by August. During the molt, geese congregate at ponds and lakes that provide a safe place to rest, feed, and escape danger.

After the molt and through the fall, geese gradually increase the distance of the feeding flights and are more likely to be found away from water. Large resident flocks, may feed on athletic fields and large lawns during the day, and return to larger lakes and ponds to roost at night. This continues until snow or ice eliminates feeding areas and forces birds to other open water areas nearby or to the south, when they remain until milder weather returns and nesting area open up.

Impacts to Native Vegetation

While vegetation in an established shoreline habitat will likely rebound after goose herbivory, plant material in a new restoration is much less likely to survive. After the initial installation, most plants need the whole growing season for roots to expand and become established. Prior to plant establishment, geese can remove while plants from the ground with ease because roots have not had a chance to expand and anchor the plant. It seems to be unintentional as they move along from plant to plant attempting to crop off the tops. Even though they do not eat the roots, the completely uprooted plants are not likely to survive.

The foraging behavior and low digestive efficiency of Canada geese are detrimental to a restoration because they will likely sweep through an entire planting if nothing is in place to control them. Geese stay away from areas of tall, dense vegetation because of predation fear, but plant plugs are small with significant space between plants, leaving open areas for the geese to move between them. Once the vegetation gets taller and fills in, they will not go near the area. After one growing season the plants will be established enough to minimize the impact of goose herbivory.

Control

There is no one technique or strategy that can be used everywhere to manage Canada geese. Complexities of sites and the current limitations of available techniques make quick-fix solutions unlikely. Currently, hunting Canada geese is legal in the Albany Pine Bush. However, hunting in the nearby Rensselaer Lake and (which is in the City of Albany's Six Mile Water Works Park) is not allowed. Resolving a problem requires an integrated management program. Short-term strategies can relieve immediate problems, and long-term approaches will maintain goose populations at or below target-levels. Combining two or more techniques often improves results.

Mechanical Control

Preferred habitat for geese is a large, unobstructed open area close to a water body. Many restorations provide such an environment in the first and second year following planting and seeding. Thus, it may be necessary to protect the native plantings from Geese herbivory in the first one or two years.

A grid or network of multiple parallel lines of wire, Kevlar, stainless-steel line, twine, cotton rope, fishing line, or mylar tape stretched 1 to 2 feet above the water surface restricts goose landing and takeoff. The lines do not have to be spaced equidistantly or be parallel. Generally, larger birds are repelled by grids with wider spacing than those effective for smaller birds. Strands can be tied to posts or poles for easy repair if lines break, or to take up excess slack. To increase effectiveness, the grid system should be in place before geese arrive. In addition, a perimeter fence should be constructed to prevent the geese from walking into the area under the grid. Grid systems can also be used over land because they prevent flying geese from landing. It is not known if this technique affects other species of waterfowl.

Fences can prevent geese from walking from water to grazing areas. Effective materials include woven wire, chicken wire, plastic snow fencing, construction silt-fencing, corn cribbing, chain link fencing, netting, mylar tape, monofilament lines, stainless-steel wire, and picket fencing. Regardless of material, openings should be no larger than 3 inches, the fence should be at least 30 inches tall, and it should be long enough to discourage geese from walking around the ends. Fences are most effective during the pre-nesting period and during flightless periods in early summer when geese have young or are molting. Deer may also walk through single or multiple-strand fences, breaking strands and increasing maintenance. The effectiveness of a barrier fence may be enhanced if landscaping modifications are also used.

Vegetative barriers, such as shrubs, hedges, and tall vegetation, may block favored pathways of geese or obstruct their line of sight, making areas less attractive because of the potential

for attack from predators. To be successful, a plant barrier must make geese feel that if they are threatened; their ability to escape is reduced. Vegetative barriers work best when goose numbers are low and available habitat nearby is unoccupied. Vegetation will not discourage the use of an area by flying geese. Any barrier planting will require protection from geese or other animals during establishment. Plants should be dense and high enough to prevent adult geese from seeing through or over them, and dense enough to prevent the geese from walking through gaps between plants or stems.

Hazing and scaring techniques are usually designed to frighten geese away from problem sites. It is permissible to harass Canada Geese without a federal or state permit as long as the geese are not touched or handled by a person or an agent of a person (i.e. dog). Hazing techniques are non-lethal and therefore are generally well accepted by the public. Hazing presents some problems, however, including habituation of the birds to the devices. Hazing is most effective if implemented before or at the initial stages of a conflict situation. Once geese have become accustomed to using an area, they are more difficult to haze or scare. Decoy swans have been used with limited success to deter geese from landing on ponds. Eagle scarecrows, snake models, falcons, mute swans and plastic alligators have all been used in attempts to deter geese, with little or no success. Dogs and radio-controlled aircraft have been used to haze geese. Companies, such as Migratory Bird Management near Chicago Illinois have recently been established to provide a comprehensive strategy to control Canadian geese problems.

A remote possibility is the use of round-ups to trap and remove Canadian geese from the project site. It is not anticipated that Canadian geese populations will reach a level where round-ups will prove an effective strategy.

Chemical Control

Chemical repellants are an attractive tool because they are visually and acoustically unobtrusive, may be applied directly to the problem area, may not harm the geese permanently, and are generally accepted by the public. Limitations on repellants include high costs, necessity to reapply them frequently, odors associated with the few registered products, influence on the behavior of other wildlife, and poor or mixed effectiveness. Repellants cannot prevent goose activities such as loafing or swimming, and they have had inconsistent or inconclusive results at reducing grazing, limiting their overall utility. Any proposed repellants for Canada goose control will be New York State approved.

Biological Control

Canada geese have a long life span once they survive their first year. The most efficient way to reduce the size of a flock is to increase the mortality among adult geese. Hunting is a major cause of goose losses, but geese may seldom be available to hunters in urban environments. Impairing reproduction can stabilize flock size, and several techniques can lower the reproduction rates. These techniques are time consuming and are most appropriate for areas with concentrated nesting sites. All of these techniques require federal and/or state permits.

Removing a nest forces breeding geese to relocate to an undisturbed area, build a new nest, or nest later in the season. Canada geese may take from a day to a week to construct a nest before they lay eggs. Destroying nests is very labor intensive, requiring daily visits to

potential nesting areas. Nest removal is further complicated by the difficulty in finding nests and the tendency of geese to nest on islands. Additionally, the nest initiation period may last for several weeks, and the first egg may be laid less than 24 hours after the nest is initiated. This technique has limited application in small areas were nests are easily accessible, visible, and labor is cheap or free. Once eggs have been laid, this technique is usually not useful.

In the interest of humane treatment, the following techniques are performed as early in incubation as possible. This must be balanced against getting to the nest after all the eggs have been laid; otherwise a repeat visit will be required to treat the remaining eggs. Oiling eggs prevents gases from diffusing through an egg's outer membranes and pores in the shell, thereby causing the embryo to die of asphyxiation. Typically, the eggs are taken out of the nest, covered with an oily substance by brushing, dunking, or spraying, and then replaced in the nest. Addling (or shaking) involves vigorously shaking the eggs until sloshing is heard, thus destroying the embryo. Puncturing is done by pushing a thin, strong pin through the shell, which introduces bacteria. The pin can be rotated inside the egg to ensure that the embryo is destroyed. The eggs are treated and replaced so that the female goose continues to incubate. If eggs are simply removed, geese generally re-nest and produce another clutch. Eggs can also be removed from the nest and replaced with dummy wood or plastic, unfertilized, or hard-boiled eggs. The goose will continue to incubate rather than re-nest.

Mute Swan (*Cygnus olor*)

Introduction

The mute swan (*Cygnus olor*), a native to Eurasia, was introduced to the North American continent from the mid-1800s through the early 1900s. Individual swans were imported to many areas of North America to adorn city parks and large estates and for zoos and aviculture collections. Although mute swans are aesthetically pleasing, their potentially deleterious effects on native ecosystems are a concern to citizens and natural resources managers. These concerns include overgrazing of submerged aquatic vegetation and competition with or the displacement of native waterfowl and other migratory birds. Mute swans can also pose a limited risk to human safety, and in some circumstances, can impact human use of private and public lands.

Life Cycle

Mute swans are the largest birds in New York, on average; adults weigh 20-25 pounds and have a wing-span of nearly seven feet. Both sexes have a black face patch with a fleshy knob on the forehead that overlays an orange bill. Mute swans generally do not nest until they are two or three years old. Nesting begins in March or early April. The swans nest very close to water, on small islands or isolated shorelines near shallow marshes. The nest itself is a large mound of vegetation, usually composed of rushes and course grasses. In freshwater wetlands, cattails are the preferred nest material. Clutch size varies from 4-10, with 6 being the average. Incubation begins after the clutch is complete and last about 35 days (mid-May to mid-June).

Peak of hatching occurs in mid-May. The cygnets leave the nest within a day or so of hatching. They become independent when 125 to 132 days old. Cygnets are able to fly in four to five months, and then may leave their parents' territory. The young birds gather in non-breeding flocks along bays and tidal tributaries where food is abundant. Typically, they will spend one to two years there before leaving and establishing a territory of their own. Mute swans are not migratory, that is they do not fly south for the winter months. They are resident primarily within their breeding range, but their winter distribution is limited by the availability of open water. Average life expectancy is about 11 years, with a maximum of 21 years.

Detrimental Impacts on Native Waterfowl

Ecological effects of the exotic mute swan on native wildlife are a concern to public and resources managers. Mute swans exhibit aggression toward other desired waterfowl, displacing native species from their breeding and feeding habitats, and sometimes attacking, injuring, or killing other birds. Year-round residency of mute swans on shallow wetlands can reduce submerged aquatic vegetation availability for native breeding and wintering waterfowl.

Detrimental Impacts of Wetland Habitat

Submerged aquatic vegetation (SAV) is a key component of wetland ecosystems. The plants are a major food source for native waterfowl. SAV beds also provide habitat and shelter for a variety of fish, shellfish, and many small invertebrates. SAV also contribute to chemical processes such as nutrient absorption and oxygenation of the water column. Dense SAV beds also aid in dissipating wave energy and slowing water currents, helping to maintain water clarity by reducing the amount of sediment suspended in the water and by preventing shoreline erosion.

Mute swans have the capability of consuming an average of eight (8) pounds of SAV per day. During feeding, mute swans have been known to completely remove individual plant species from some wetlands, eliminating this food sources for other waterfowl species. Mute swans uproot large quantities of aquatic plants, and can disturb much more vegetation than they actually eat. Mute swans not only pull out the whole plants while feeding, but also use foot movements to help dislodge plants. Sometimes, this is done to provide food for the cygnets. In extreme cases, the bottom substrate is left barren.

Control

The New York Department of Environmental Conservation (NYSDEC) has developed a policy to prevent further growth of the feral mute swan populations. The NYSDEC encourages landowners to control swans on their own property. Measures that may be used include harassment (scaring the birds away), egg-shaking, and removal. Swans removed must either be humanely killed or be adopted by individuals who are licensed to keep captive birds. Mute swans are protected by the New York State Environmental Conservation Law. Therefore, swans, as well as their nests and eggs, may not be handled or harmed without authorization from NYSDEC.

White-tailed Deer (*Odocoileus virginianus*)

Introduction

The white-tailed deer is tan or brown in the summer and grayish brown in winter. It has white on its throat, around its eyes and nose, on its stomach and on the underside of its tail. Males weigh between 150 and 300 pounds, and females weigh between 90 and 200 pounds.

The white-tailed deer can be found in southern Canada and most of the United States. A deer's home range is usually less than one square mile around wooded areas. Deer collect in family groups of a mother and her fawns. When a doe has no fawns, she is usually solitary. Male bucks live in groups consisting of three or four individuals, except in mating season, when they are solitary.

The white-tailed deer is an herbivore, with a ruminant stomach consisting of a four-chambered stomach allowing it to eat woody plants that other animals cannot digest. It feeds early in the morning hours and late afternoon. A deer's diet changes depending on its habitat and the season. It eats green plants in the spring and summer, and in fall, eats corn, acorns, and other nuts. In winter, it eats the buds and twigs of woody plants.

Life Cycle

White-tailed deer mate in November in the northern parts of their range and in January of February in the southern parts of their range. The female has one to three fawns about six months after mating. Fawns are reddish-brown at birth with white spots that help camouflage them. They can walk at birth and forage for food a couple of days later. They are weaned at about six weeks. The mother leaves her fawns well-hidden for hours at a time while she feeds. If she has more than one fawn, she hides them in separate places. Female fawns may stay with their mothers for two years, males usually leave after a year.

Mechanical Control Methods

The preferred option for mechanical control is the use of permitted hunting. Permitted hunting is currently allowed in the Albany Pine Bush. Controlled hunts have been successful in several locations to reduce the population size of a herd. Selection of hunting techniques will depend on local circumstances, including parcel size, deer numbers, problem severity, and the potential for conflict. Archery hunting for deer has the advantage of being a relatively discreet and silent activity. The limited shooting range for archery equipment, coupled with the tendency for archers to hunt from tree stands, makes archery hunting a safe and non-disruptive removal technique. Normal permitted hunting practices should keep deer densities at acceptable levels. If densities increase it is recommended that the NYSDEC be approached about issuances of a NYSDEC deer damage permit. This would allow deer to be shot under specific conditions and circumstances.

Fencing is a reliable method to address site-specific problems such as landscape or agricultural damage. Several factors should be assessed before using fencing as a deer control option. These include fence design, site history, deer density, crop or landscape value, local ordinances, and size of the area to be protected. Barrier fencing performs well even under

intense deer pressure and represents the technique of choice for many deer damage management programs. Individual wired cages, at least 1.5 feet in diameter and three to four feet in height, may be used to protect single trees from deer browsing and antler rubbing. Several types of plastic tubes, tree wraps, and bud caps are also available. A high-tensile, woven-wire fence that is eight to ten feet tall is considered the most deer-proof design.

Several hazing and frightening techniques can be used to keep deer away from specific areas. Hazing has been effective under certain circumstances, however, deer often habituate to novel disturbances. In addition, deer may not leave the general vicinity and complaints may arise from neighbors about the noise made by devices. Hazing is most effective if implemented either before or at the initial stages of a conflict situation. Deer movements or behavioral patterns are difficult to modify once they have been established. Pyrotechnics provide quick but temporary relief from deer damage on farms. Pyrotechnics and propane cannons, however, have limited application in suburban settings because of the disturbance to community members.

Motion-sensing detectors have been used to trigger both audible and ultrasonic devices for frightening deer in an effort to minimize habituation. Strobes, sirens, water sprays, and other devices have been used to frighten deer with limited effectiveness. Although deer can detect ultrasound, they are not repelled by it because they do not associate the disturbance with danger.

Trapping and translocation control methods requires the use of traps, nets, and or remote chemical immobilization (i.e. darts) to restrain deer and shipping crates to translocate captured animals. Capture and translocation has been demonstrated to be impractical, stressful to the deer handled, and may result in high post-release mortality. Trap and translocation programs also require release sites that are capable of receiving deer, and such areas are often scarce. It is unlikely the NYSDEC would authorize the trapping and translocation of deer in the Albany Pine Bush.

Chemical Control Methods

Repellants are best suited for use in orchards, nurseries, gardens, and on ornamental or other high-value plants. High application cost, label restrictions on use, and variable effectiveness make most repellants impractical for row crops, pastures, or other low-value commodities. Success with repellants should be measured in reduction of damage; total elimination of damage should not be expected. Any repellant proposed for use to control deer populations will be New York State approved.

Appendix B

Alphabetical Listing of Invasive Flora Species and Management Techniques

Garlic Mustard (*Alliaria petiolata*)

Introduction

Garlic mustard poses a severe threat to native plants and animals in forest communities in much of the eastern and Midwestern U.S. Many native wildflowers that complete their life cycles in the spring time (e.g. spring beauty, wild ginger, bloodroot, Dutchman's breeches, hepatica, toothworts, and trilliums) occur in the same habitat as garlic mustard. Once introduced to an area, garlic mustard out-competes native plants by aggressively monopolizing light, moisture, nutrients, soil and space. Wildlife species that depend on these early plants for their foliage, pollen, nectar, fruits, seeds and roots, are deprived of these essential food sources when garlic mustard replaces them.

After spending the first half of its two-year life cycle as a rosette of leaves, garlic mustard plants develop rapidly the following spring into mature plants that flower, produce seed and die by late June. In the mid-Atlantic Coastal Plain region, seeds are produced in erect, slender, four-sided pods, called siliques, beginning in May. Siliques become tan and papery as they mature and contain shiny black seeds in a row. By late June, most of the leaves have faded away and garlic mustard plants can be recognized only by the dead and dying stalks of dry, pale brown seedpods that may remain and hold viable seed throughout the summer.

A single plant can produce thousands of seeds, which scatter as much as several meters from the parent plant. Depending upon conditions, garlic mustard flowers either self-fertilize or are cross-pollinated by variety of insects. Self-fertilized seed is genetically identical to the parent plant, enhancing its ability to colonize an area. Although water may transport seeds of garlic mustard, they do not float well and are probably not carried far by wind. Long distance dispersal is most likely aided by human activities and wildlife. Additionally, because white-tailed deer prefer native plants to garlic mustard, large deer populations may help to expand it by removing competing native plants and exposing the soil and seedbed through trampling.

Garlic mustard also poses a threat to one of our rare native insects, the West Virginia white butterfly (*Pieris virginiensis*). Several species of spring wildflowers known as "toothworts" (*Dentaria* spp), also in the mustard family, are the primary food source for the caterpillar stage of this butterfly. Invasions of garlic mustard are causing local extirpations of the toothworts, and chemicals in garlic mustard appear to be toxic to the eggs of the butterfly, as evidenced by their failure to hatch when laid on garlic mustard plants.

Garlic mustard has been found to release chemicals into the soil that are harmful to the surrounding soil fungi that the native maple, ash and other hardwood trees depend. The chemical targets the arbuscular mycorrhiza fungi (AMF), which form mutually beneficial relationships with many native forest trees.

Description

Garlic mustard was first recorded in the United States about 1868, from Long Island, New York. It was likely introduced by settlers for food or medicinal purposes. Garlic mustard is

a cool season biennial herb with stalked, triangular to heart-shaped, coarsely toothed leaves that give off an odor of garlic when crushed. First-year plants appear as a rosette of green leaves close to the ground. Rosettes remain green through the winter and develop into mature flowering plants the following spring. Flowering plants of garlic mustard reach from 2 to 3-1/12 feet in height and produce button-like clusters of small white flowers, each with four petals in the shape of a cross.

Recognition of garlic mustard is critical. Several white-flowered native plants, including toothworts (*Dentaria species*), sweet cicely (*Osmorhiza claytonii*), and early saxifrage (*Saxifraga virginica*), occur alongside garlic mustard and may be mistaken for it.

Beginning in May (in the mid-Atlantic Coast Plain region), seeds are produced in erect, slender pods and become shiny black when mature. By late June, when most garlic mustard plants have died, they can be recognized only by the erect stalks of dry, pale brown seedpods that remain, and may hold viable seed, through the summer.

Garlic mustard frequently occurs in moist, shaded soil of river floodplains, forests, and road sides, edges of woods and trails edges and forest openings. Disturbed areas are most susceptible to rapid invasion and dominance. Though invasive under a wide range of light and soil conditions, garlic mustard is associated with calcareous soils and does not tolerate high acidity. Growing season inundation may limit invasion of garlic mustard to some extent.

Habitat

Garlic mustard can grow almost anywhere, but is most aggressive in rich, moist, shady locations. Garlic mustard spreads quickly and is easily established along roadsides, flooded stream banks, forest understories, and trail edges. Although garlic mustard is extremely tolerant of many environmental factors, it cannot tolerate extremely acidic soils, including muck and undrained peat.

Control Methods

Mechanical Control

Because the seeds of garlic can remain viable in the soil for five years or more, effective management requires a long term commitment. The goal is to prevent seed production until the stored seed is exhausted. Hand removal of plants is possible for light infestations and when desirable native species co-occur. Care must be taken to remove the plant with its entire root system because new plants can sprout from root fragments. This is best achieved when the soil is moist, by grasping low and firmly on the plant and tugging gently until the main root loosens from the soil and the entire plant pulls out. Pulled plants should be removed from site if at all possible, especially if flowers are present as seed ripening can occur even after the plants are pulled. Garlic mustard typically spreads from an established infestation along an invasion front, with scattered small localized populations or individuals at some distance. These outliers usually occur along trails, roads, and forest edges. Hand pulling of these outliers is a top priority

For medium to large infestations of garlic mustard or when hand-pulling is not practical, flowering stems can be cut at ground level or within several inches of the ground, to prevent seed production. If stems are cut too high, the plant may produce additional flowers at leaf

axils. Once seedpods are present, but before the seeds have matured or scattered, the stalks can be clipped, bagged and removed from the site to help prevent continued buildup of seed stores. This can be done through much of the summer. It will be necessary to cut and pull plants for at least five consecutive years or until the seed bank is exhausted.

Prescribed Burning

Fire has been used to control garlic mustard in some large natural settings but, because burning opens the understory, it an encourage germination of stored seeds and promote growth of emerging garlic mustard seedlings. For this reason, burns must be conducted for three to five consecutive years to ensure that seed stores of garlic mustard have been exhausted. Dormant season fires (i.e. March) are ineffective for garlic mustard control. Growing season burns (i.e. May) can suppress garlic mustard but also adversely affects the native understory plants.

Chemical Control

For very heavy infestations, where the risk to desirable plant species is minimal, application of the systemic herbicide glyphosate (e.g., Roundup®) is also effective. Herbicide may be applied at any time of year, including winter (to kill overwintering rosettes), as long as the temperature is above 50 degrees F. and rain is not expected for about 8 hours. Extreme care must be taken not to get glyphosate on desirable plants as the product is non-select and will kill almost any plant it contacts. Spray shields may be used to better direct herbicide and limit non-intentional drift.

Biological Control

Research in North America on potential biological control agents began in 1998. Researchers are investigating potential biological control agents for garlic mustard which may greatly improve the control of this insidious weed. The most promising agents include five weevil species and one flea beetle. A computer model has been developed that can assess likely potential control agents prior to field release. The model has selected a weevil as a potential biological control agent, but to date has not been released into North America. Currently no approved biological control exists for garlic mustard. However, depending on Federal approvals a weevil was scheduled for release sometime in 2008.

Japanese Barberry (*Berberis thunbergii*)

Introduction

Japanese barberry forms dense stands in natural habitats including canopy forests, open woodlands, wetlands, pastures, and meadows. The plant alters soil pH, nitrogen levels, and biological activity in the soil. Barberry displaces native plants and reduces wildlife habitat and forage. White-tailed deer apparently avoid browsing barberry, preferring to feed o native plants, giving barberry a competitive advantage. Due to its ornamental interest, barberry is still widely propagated and sold by nurseries for landscaping purposes in many parts of the U.S.

Japanese barberry spreads by seed and by vegetative expansion. Barberry produces large numbers of seeds which have a high germination rate, estimated as high as 90%. Barberry seed is transported to new locations with the help of birds (e.g., turkey and ruffed grouse) and small mammals which eat it. Birds frequently disperse seed while perched on powerlines or on trees at forest edges. Vegetative spread is through branches touching the ground that can root to form new plants and root fragments remaining in the soil that can sprout to form new plants.

Description

Japanese barberry is a dense, deciduous, spiny shrub that grows 2 to 8 feet in height. Branches are brown, deeply grooved, somewhat zig-zag and bear a single, sharp spine at each node. The leaves are small (1/2 to 1-1/2 inches long), oval to spatula-shaped, green, bluish-green, or dark reddish purple. Flowering occurs from mid-April to May in the northeastern U.S. Pale yellow flowers about ¼ in. (0.6 cm) across, hang in umbrella-shaped clusters of 2-4 flowers each, along the length of the stem. The fruits are bright red berries about 1/3 in. (1 cm) long that are born on a narrow petiole. Fruits mature during late summer and fall and can persist throughout the winter.

Japanese barberry can sometimes be confused with American barberry (*Berberis canadensis*), the only native species of barberry in North America, and common or European barberry (*Berberis vulgaris*) which are an introduced, sometimes invasive plant.

Habitat

Barberry is shade tolerant, drought resistant, and adaptable to a variety of open and wooded habitats, wetlands and disturbed areas. It prefers to grow in full sun to part shade but will flower and fruit even in heavy shade. It is native to Japan, but has been reported in twenty states in the Midwest and Northwest.

Japanese barberry was introduced to the U.S. and New England as an ornamental plant in 1875. In 1896, barberry shrubs grown from these seeds were planted at the New York Botanic Garden. Japanese barberry was later promoted as a substitute for common barberry (*Berberis vulgaris*) which was planted by settlers for hedgerows, dye and jam, and later found to be a host for the black stem grain rust. Because Japanese barberry has been cultivated for ornamental purposes for many years, a number of cultivars exist.

Control Methods

Mechanical Control

Do not plant Japanese barberry. Because it is a prolific seed-producer with a high germination rate, prevention of seed production should be a management priority. Because barberry can re-sprout from root fragments remaining in soil, thorough removal of root portions is important. Manual control works well but may need to be combined with chemical in large or persistent infestation.

Because Japanese barberry leafs out early, it is easy to identify and begin removal efforts in early spring. Small plants can be pulled by hand, using thick gloves to avoid injury from the spines. The root system is shallow making it easy to pull plants from the ground, and it is important to get the entire root system. The key is to pull when the soil is damp and loose. Young plants can be dug up individually using a hoe or shovel. Hand pulling and using a

shovel to remove plants up to about 3 ft. high is effective if the root system is loosened up around the primary tap root first before digging out the whole plant.

Mechanical removal using a hoe or Weed Wrench® can be very effective and may pose the least threat to non-target species and the general environment at the site. Tools like the Weed Wrench® are helpful for uprooting larger or older shrubs. Shrubs can also be mowed or cut repeatedly. If time does not allow for complete removal of barberry plants at a site, mowing or cutting in late summer prior to seed production is advisable.

Chemical Control
Treatments using the systemic herbicides glyphosate (e.g., Roundup®) and triclopyr (e.g., Garlon) have been effective in managing Japanese barberry infestations that are too large for hand pulling. For whole plant treatment, apply a 2% solution of glyphosate mixed with water and a surfactant. This non-selective herbicide should be used with care to avoid impacting non-target native plants. Application early in the season before native vegetation has matured may minimize non-target impacts. However, application in late summer during fruiting may be most effective. Triclopyr or glyphosate may be used on cut stumps or as a basal bark application in a 25% solution with water, covering the outer 20% of the stump.

Biological Control
No biological control organisms are available for this plant.

Smooth Brome (*Bromus inermis*)

Introduction
Smooth brome (*Bromus inermis*) is a cool season exotic that is especially troublesome in disturbed portions of old pastures in the tall grass and mixed prairie regions. Although less invasive than some other cool season non-native grasses, it is less responsive to management techniques. Smooth brome is highly competitive.

Description
Smooth brome is an introduced perennial grass, standing 2 ½ to 3 ½ feet tall and is usually unbranched. The culms are dark green, hairless or slightly pubescent, and terete. The blades of the alternate leaves are up to 10 inches and 2/3 inch across; they are grayish blue on the upper side, green on the lower side, hairless, and flat. The leaf blades are ascending to spreading and somewhat drooping. The leaf sheaths are grayish blue, hairless, and closed.

Habitat
Smooth brome is a common grass that is found in almost all counties in New York. It was introduced as a pasture or forage grass from Eurasia. Habitats include pastures, fallow fields, and grassy areas along roadsides, degraded meadows, no-mow areas of parks, and waste areas.

Control Methods
Mechanical Control

Management experience indicate that cutting smooth brome in the boot stage, i.e. while the flowering head is still enclosed within the sheath, is perhaps the most effective means of control. The best conditions for damage are hot, moist weather at the time of cutting, followed by a dry period. Management would include a lawn mowing of brome in late May (approximately 18 inches in height) and mowing at least 4 times during the season where brome patches are monotypic. Fire does not appear as effective in reducing smooth brome as some other non-native species.

Chemical Control
Several New York State approved herbicides such as glyphosate (i.e. Roundup), can be effectively applied to dense populations in April or May. Imazapyr (Arsenal) has also been approved for control in New York. Table 3 provides potential herbicides that are New York State approved. However, most herbicides are not specific to the plant, and care must be taken to avoid non-target species.

Biological Control
Currently, there are no biological control agents for use on smooth brome.

Oriental bittersweet (*Celastrus orbiculatus*)

Introduction
Oriental bittersweet is a vigorously growing vine that climbs over and smothers vegetation which may die from excessive shading or breakage. When bittersweet climbs high up on trees the increased weight can lead to uprooting and blow-over during high winds and heavy snowfalls. In addition, Oriental bittersweet is displacing our native American bittersweet (*Celastrus scandens*) through competition and hybridization.

Note: because Oriental bittersweet can be confused with our native American bittersweet (*Celastrus scandens*) which is becoming less and less common, it is imperative that correct identification be made before any control is begun. American bittersweet produces flowers (and fruits) in single terminal panicles at the tips of the stems; flower panicles and fruit clusters are about as long as the leaves; the leaves are nearly twice as long as wide and are tapered at each end. Oriental bittersweet is a prolific fruiter with lots and lots of fruit clusters emerging at many points along the stem. Unfortunately, hybrids of the two occur which may make identification more difficult.

Oriental bittersweet infests forest edges, woodlands, fields, hedgerows, coastal areas and salt marsh edges, particularly those suffering some form of land disturbance. While often found din more open, sunny sites, its tolerance for shade allows oriental bittersweet to invade forested areas.

Introduced into the U.S. in the 1860s as an ornamental plant, oriental bittersweet is often associated with old home sites, from which it has escaped into surrounding natural areas. Oriental bittersweet is still widely planted and maintained as an ornamental vine, further promoting its spread.

Description
Oriental bittersweet reproduces prolifically be seed, which is readily dispersed to new areas by many species of birds including mockingbirds, blue jays and European starlings. The seeds germinate in late spring. It also expands vegetatively through root suckering.

Habitat
Oriental bittersweet has a wide range of habitat preferences including roadsides, old homesteads, thickets, and alluvial woods. Oriental bittersweet is shade tolerant, readily germinating and growing under a closed forest canopy.

Control Methods
Management
Manual, mechanical and chemical control methods are all effective in removing and killing Oriental bittersweet. Employing a combination of methods often yields the best results and may reduce potential impacts to native plants, animals and people. The method you select depends on the extent and type of infestation, the amount of native vegetation on the site, and the time, labor and other resources available to you. Whenever possible and especially for vines climbing up trees or buildings, a combination of cutting followed by application of concentrated systemic herbicide to rooted, living cut surfaces is likely to be the most effective approach. For large infestations spanning extensive areas of ground, a foliar herbicide may be the best choice rather than manual or mechanical means which could result in soil disturbance.

Mechanical Control
Small infestations can be hand-pulled but the entire plant should be removed including all the root portions. If fruits are present, the vines should be bagged in plastic trash bags and disposed of in a landfill. Always wear gloves and long sleeves to protect your skin from poison ivy and barbed or spined plants. For climbing vines, first cut the vines near the ground at a comfortable height to kill upper portions and relieve the tree canopy. Vines can be cut using pruning snips or pruning saw for smaller stems or a hand axe or chain saw for larger vines. Try to minimize damage to the bark of the host tree. Rooted portions will remain alive and should be pulled, repeatedly cut to the ground or treated with herbicide. Cutting without herbicide treatment will require vigilance and repeated cutting because plants will re-sprout from the base.

Chemical Control
Systemic herbicides like triclopyr (e.g., Garlon® 3A Garlon® 4) and glyphosate (e.g., Accord®, Roundup®, Rodeo®) are absorbed into plant tissues and carried to the roots, killing then entire plant within about a week. This method is most effective if the stems are first cut by hand or mowed and herbicide is applied immediately to cut stem tissue. Herbicide applications an be made any time of year as long as temperatures are above 55 or 60 degrees Fahrenheit for several days and rain is not expected for at least 24 hours. Fall and winter applications will avoid or minimize impacts to native plants and animals. Repeated treatments are likely to be needed. In areas where spring wildflowers or other native plants occur, application of herbicides should be conducted prior to their emergence, delayed until late summer or autumn, after the last killing frost occurs, or carefully targeted. Herbicidal contact with desirable plants should always be avoided. If native grasses are

intermingled with the bittersweet, triclopyr should be used because it is selective for broad-leaved plants and will not harm grasses. Follow-up monitoring should be conducted to ensure effective control.

Glyphosate products referred to in this fact sheet are sold under a variety of band names (Accord®, Rodeo®, Roundup Pro® Concentrate) and in three concentrations (41.0, 50.2 and 53.8% active ingredient). Other glyphosate products sold at home improvement stores may be too dilute to obtain effective control. Triclopyr comes in two forms – triclopyr amine (e.g., Garlon® 3A, Brush-B-Gone®, Brush Killer®) and triclopyr ester (e.g., Garlon® 4, Pathfinder®, and Vinex®). Because Garlon® 3A is a water-soluble salt that can cause severe eye damage, it is imperative that you wear protective goggles to protect yourself from splashes. Garlon® 4 is soluble in oil or water, is highly volatile and can be extremely toxic to fish and aquatic invertebrates. It should not be used in or near water sources or wetlands and should only be applied under cool, calm conditions.

Basal Bark Application
Use a string trimmer or hand saw to remove some of the foliage in a band a few feet from the ground at a comfortable height. To the exposed stems, apply a 20% solution of triclopyr ester (Garlon® 4) (2.5 quarts per 3-gallon mix) in commercially available basal oil with a penetrant (check with herbicide distributor) to vine stems. As much as possible, avoid application of herbicide to the bark of the host tree. This can be done year-round although efficacy may vary seasonally; temperatures should be above 50 degrees F for several days.

Cut Stem Application
Use this method in areas where vines are established within or around non-target plants or where vines have grown into the canopy. Cut each vine stem close to the ground (about 2 in. above ground) and immediately apply a 25% solution of glyphosate (e.g., Accord®) or triclopyr (e.g., Garlon® 3A) mixed with water to the cut surface of the stem. The glyphosate application is effective at temperatures as low as 40 degrees F and a subsequent foliar application may be necessary. The triclopyr application remains effective at low temperatures (<60 degrees F) as long as the ground is not frozen. A subsequent foliar application may be necessary to control new seedlings. Homeowners can apply products like Brush-B-Gone®, Brush Killer® and Roundup Pro® Concentrate undiluted to cut stems. Using a paint brush or a plastic spray bottle, apply herbicide to the cut surface.

Foliar Application
Use this method to control extensive patches of solid bittersweet. It may be necessary to precede foliar applications with stump treatments to reduce the risk of damaging non-target species. During foliar applications some of the herbicide is also absorbed through the stem for additional (basal bark) effect. Apply a 2% solution (8 oz. per 3 gal. mix) triclopyr ester (Garlon® 4) or triclopyr amine (Garlon® 3A) mixed in water with a non-ionic surfactant to the leaves. In Rhode Island, concentrations as low as 1% in mid-summer and 0.055 in September have been very effective. Thoroughly wet the foliage but not to the point of runoff. The ideal time to spray is after much of the native vegetation has become dormant (October-November) to avoid affecting non-target species. A 0.5% concentration of a non-ionic surfactant is recommended in order to penetrate leaf cuticle. If the 2% rate is not effective try an increased rate of 3-5%. Ambient air temperature should be above 65 degrees F.

For dense, low patches of bittersweet another alternative is to cut the entire patch to the ground early in the growing season. About one month later, apply 1-2% solution of triclopyr ester (Garlon 4) or triclopyr salt (Garlon 3A) in water to the previously cut patch using a backpack spray. This method has resulted in complete root kill of the bittersweet and no off-target damage or root uptake by adjacent plants.

Biological Control
No biological controls are currently available for this Oriental bittersweet.

Spotted Knapweed (*Centaurea maculosa)* and other Knapweeds (Cenaurea spp.)

Introduction
Spotted knapweed is an aggressive, introduced weed species that rapidly invades pasture, rangeland and fallow land and causes a serious decline in forage and crop production. The weed is a prolific seed producer with 1,000 or more seeds per plant. Seed remains viable in the soil five years or more, so infestations may occur a number of years after vegetative plants have been eliminated. Spotted knapweed has few natural enemies and is consumed by livestock only when other vegetation is unavailable. The plant releases a toxin that reduces growth of forage species. Areas heavily infested with spotted knapweed often must be reseeded once the plant is controlled.

Historic records indicate that spotted knapweed was introduced from Eastern Europe into North America in the early 1900s as a contaminant in crop seed. It now infests several million acres of grazing land in the northwestern United States and Canada.

People are the major cause of spotted knapweed spread. The weed is spread readily in hay and on vehicle undercarriages. Producers should exercise caution when using hay from road ditches, especially primary roadways, and when purchasing hay from known infested areas in neighboring states and provinces.

Producers must learn to identify spotted knapweed and be aware of potential harmful effects before it becomes established. Producers should watch for the weed on their own land, especially on disturbed sites, pastures, bordering roads and streams, and where hay is fed. Timely control of a few plans will be very cost effective compared to treating a larger acreage later. The public can assist county weed officials in controlling spotted knapweed by reporting all suspected infestations of the weed.

Description
Spotted knapweed generally is a short-lived perennial, reproducing solely by seeds. Seeds are brownish, less than ¼ inch long, notched on one side of the base, with a short tuft of bristles at the tip. The seeds may germinate from spring through early fall. Seedlings emerging in the fall often overwinter as a rosette of leaves, resuming growth again in the spring. The plant grows 2 to 4 feet tall and bears alternate, pale green leaves which are 1 to 3 inches long. Leaf margins of the lower leaves are divided and smooth while the surface of

the leaf is rough. The upper leaves are linear in shape. Stems are erect and rough, with slender branches. Numerous flowers are produced from early July through August. Flowers are pink to light purple and are borne on tips of terminal or axillary stems. The flower petals are surrounded by stiff, black-tipped bracts, giving the flower head a spotted appearance.

Habitat
Spotted knapweed is found on heavily disturbed sites, edges of agricultural fields, roadsides, undisturbed prairies, oak and Pine Barrens, rangelands, sandy ridges, and lake dunes. The most common habitat of spotted knapweed is sunny habitats with well-drained or gravelly soils.

Control Methods
Mechanical Control
Early detection and removal of colonizing plants is vital for easy control or elimination of spotted knapweed. Outlying plants should be controlled before main populations. Small infestations can be removed by digging or pulling when the soil is moist.

CAUTION: Some individuals experience skin reactions following spotted knapweed exposure. Wear proper clothing (gloves, long pants and sleeves, etc.) when handling this species.

The entire root should be removed to prevent re-sprouting. Pulling is easiest on sandy soils after stems emerge and are big enough to grasp. Flowering plans should be bagged, removed from the site, and properly disposed of to make sure that seeds do not mature. Attempting to pull plants in the rosette stage, often results in breaking the plant off at the crown, unless roots are loosened with a hand trowel or small shovel. A disadvantage of pulling is that it may bring more seeds to the soil surface and result in more germination. Revisiting the site for several years to eliminate new plants is essential.

Annual burns have reduced spotted knapweed populations from 5 to 90 percent. Reductions seem to be related to the intensity of the burn, which is dependent on the amount of grasses and sedges present. Burns that remove nearly all the duff are most effective at killing knapweed roots and normally succeed only in newly infested areas. Before using an intense burn, consider its impact on native plants in the area. If burns have effectively reduced most of the population, remove any remaining plants by pulling and digging. Reseed burned areas with native species, if they fail to reemerge.

Mowing at the start of flowering can help limit seed production. Mowing later may spread viable seeds.

Plowing may kill the current knapweed population and other existing vegetation, but new knapweed plants will undoubtedly emerge from the seedbank.

Grazing by sheep and goats may decrease spotted knapweed seed production for that year but will likely damage other vegetation.

Chemical Control

The best spotted knapweed control is prevention. The plant generally is easy to control with herbicides but an area must be monitored for several years and retreated as necessary for seedling control.

Picloram (Tordon) at 0.25 to 0.5 pounds (1 to 2 pints) (1 to 2 pints) per acre will control spotted knapweed plants and seedlings for two to three years. The residual control period may be shorter on gravel soils, in wet areas, and where soil organic matter is high. The optimum application time is when the plant is in the rosette growth stage in the fall or in the bud to bloom stage in the spring. Do not use picloram near water or where a sandy porous surface and substrata overlie ground water 10 feet or less below the surface. Do not allow picloram spray to fall onto surface water, banks or bottoms of irrigation ditches, streams or rivers. Consult label for grazing restrictions.

Picloram, dicamba, or clopyralid + 2,4-D (Curtail) can be used to control small infestations. One to two ounces per gallon of either of these herbicides should be mixed in a hand-held single nozzle sprayer and applied until runoff. Treat an extra 10 to 15 feet around the spotted knapweed patches to control roots and seedlings. A careful follow-up program is necessary to control missed plants and seedlings. A careful follow-up program is necessary to control missed plants and seedlings. Many attempts to control spotted knapweed have failed because follow-up treatments were not applied. Application can be made anytime during the growing season, but control is best in the fall or in the bud to bloom stage in the spring to prevent seed set. Fall application of dicamba or 2,4-D at 1.0 to 2.0 pounds (1.0 to 2.0 quarts of a 4-pound-per gallon concentration) per acre to spotted knapweed in the rosette stage of growth will give good control.

Dicamba (Banvel) at 1 to 2 pounds (1 to 2 quarts) per acre will give good spotted knapweed control, but residual control of seedlings is shorter than with picloram. An annual follow-up treatment of 2,4-D at 1.0 pound (1 quart of a 4-pound-per-gallon concentration) per acre for a minimum of two years may be needed to prevent re-infestation by seedlings. Note: The waiting period after dicamba treatment for grazing dairy animals varies from seven to 60 days depending on the rate applied. No waiting period is required for non-dairy animals. Meat animals should be removed from dicamba treated areas 30 days prior to slaughter.

Clopyralid + 2,4-D (Curtail) will provide good control of spotted knapweed with less soil residual than picloram or dicamba. Control is greatest when fall applied at 0.19 + 0.28 + 1 to 1.5 pounds per acre (4 to 6 pints per acre of Curtail). A follow-up treatment the following year may be necessary to control seedlings.

Picloram and dicamba are expensive treatments, especially if spotted knapweed infests a large area. Spotted knapweed can be controlled in the rosette stage in the fall or early spring by 2,4-D low volatile ester, oil soluble amine or water soluble amine formulations at 2 pounds (2 quarts of a 4-pound-per-gallon concentration) per acre. Application of 2,4-D after stem elongation of spotted knapweed is not very effective. No residual control is provided by 2,4-D, and annual spraying is necessary until spotted knapweed seed is no longer viable. This may require several years of annual treatment.

Biological Control
Several insects such as seed-head flies (*Urophora affinis* and *U. quadrifasciata*) and a moth (*Agapet zoegana*) whose larvae feed on the roots of knapweed, have been released in the upper Midwest. Other insects have been released further west to control knapweed.

Thistle (*Cirsium species*)

Introduction
Thistles can greatly reduce species diversity in old fields, disturbed natural areas, and areas under restoration. It is imperative to control all non-native thistle species prior to restoration work. Canada thistle *(Cirsium arvense),* a perennial thistle is the species that is of concern at the Albany Rapp Road landfill mitigation site. Canada thistle has an aggressive creeping root that can grow laterally up to 19 feet per season. Leaf shape and size is highly variable. Flowering occurs from June to October and seeds are formed from July to October and remain viable for several years. Most spreading of Canada thistle occurs from vegetative buds that arise from the roots.

Description
The leaves of Canada thistle are simple; alternate; lance-shaped; tapering; irregularly lobed; spiny with toothed margins. The leaves are green on both sides, stalk less, and smooth on top and sometimes wooly underneath. The fragrant rose-purple to lavender flowers are numerous, ranging from 0.375 – 0.625 inches in diameter. The flowers are typically clustered with spineless tipped bracts. Blooming time is June through September.

Habitat
The habitat of thistles includes disturbed open areas, roadsides, agricultural fields, savannas, prairies, with clay to gravelly soils. Thistles can sometimes be found in wetlands, if dry periods occur throughout the year.

Control Methods
Mechanical Control
Eliminating seed production is the most effective mechanical control technique. Thistles mowed in bud or early bloom stage will produce new branches from buds in the axils of the basal leaves. However, close mowing or cutting twice per season will usually prevent seed production. Mowing once flowering has begun may result in the spread of viable seeds with the mower. For light to moderate infestations, repeat pulling, hand-cutting or mowing with a brush cutter is also an option. Plants should be pulled or cut at least three times during the growing season.

Cultivation schedules starting in May and continued at 10-15 day intervals for up to two years have been found to be effective. The use of thermal (steam) weed control can be used as an alternative method from mechanical cultivation. The plants are steamed using trailer mounted Atarus Stinger Steamer generators that heat the steam up to 800 degrees F. Multiple applications are required to provide season long management.

Chemical Control
Chemical control is most effective when plants are in the rosette stage and least effective when thistles are flowering. Spot application of 2,4-D, Arsenal, and Triclopyr (Garlon 3A & 4) using a wick applicator or hand sprayer can control individual stems (Table 3). Infested lands that are not considered high quality natural areas may be controlled using a foliar application of glyphosate in spring when plants are 6-10 inches tall.

There are two organic herbicides that are effective over many years. These are AllDown and BurnOut II. AllDown green chemistry herbicide organic weed and grass killer is a non-selective herbicide and contains high concentrations of vinegar, garlic, and other organic ingredients. BurnOut II is also a non-selective herbicide that contains acetic acid and other organic ingredients. These products provide non-translocating burndown action. It is not known if either is approved for use in New York State

Biological Control
Two exotic weevils, the flower head weevil (*Rhinocyllus conicus*) and the rosette weevil (*Trichosirocalus horridus*) have been introduced in several states, and appear to be effective biological control agents that limit populations of certain thistle species. However, these insects are not to be used in areas where populations of native thistles exist.

Black Swallow-wort (*Cynanchum louiseae*; syn. *Vincetoxicum nigrum*)

Introduction
Black swallow-wort is an herbaceous perennial from southwestern Europe that has caused considerable ecological damage in the northeastern United States, particularly in New York by outcompeting native wildflowers and young trees. It also may affect future monarch butterfly populations that lay their eggs on this species, versus milkweed (*Asclepias species)* their typical host plants.

Eradication of black swallow-wart is difficult once a colony is established due to the dense, knobby mass of underground roots. Initial control efforts should concentrate on plants in sunny areas since they produce the largest quantity of viable seeds.

Description
Black swallow-wort is a perennial, herbaceous vine with pointed-tipped oval leaves. The leaves range from 3 to 4 inches long and 2 to 3 inches wide and are often paired on the stem. The flowers have five star-shaped petals with white hairs, ranging in color from dark purple to black. The fruit of black swallow-wort is slender, tapered pods that are green to light brown in color.

Habitat
Black swallow-wort is typically found in upland areas and is tolerant to variable light, salt, and moistures conditions. In the United States, it is often found in abandoned fields, hedgerows, woodlands, utility corridors, agricultural fields, river banks, and woodlands.

Control Methods

Mechanical Control

Hand pulling must be accompanied by digging up root crowns as well. The stems tend to break easily above the root crown if pulled while the root crown itself is held tenaciously in place by the fibrous root system and has several perennating buds which can readily re-sprout if the stems are cut or broken. If the root crown is pulled up, it must be removed from site and/or destroyed because broken root crowns on the ground have been observed to re-grow. Mowing presents the same rapid re-sprouting problem as manual pulling alone. Fruits of the black swallow-wort can be manually removed and carried off-site to prevent seed dispersal, but this practice is time consuming and must be continued until no pods are produced and the plants have reached the end of the growing season. It is more effective to remove the entire plant by mowing or hand-pulling.

Chemical Control

The response of black swallow-wort to herbicides varies by site and site conditions. Herbicide choice for foliar spray treatments will depend on site conditions. In degraded patches with little desirable vegetation, glyphosate may be preferred. At sites with desirable grasses that should be conserved, triclopyr is the recommended herbicide. Table 3 provides additional information on potential herbicides for use in managing Black swallow-wort.

Biological Control

Black swallow-wort appears to have few pests, disease or other natural controls in North America. Currently no biological control has been identified for use in North America.

Russian-Olive (*Elaegnus angustifolia*)

Introduction

Some land managers and residents view Russian-olive as a critical component of arid landscapes. Others curse it as a dreaded weed. Russian-olive thrives under extreme environmental conditions (e.g., temperature, moisture, soils) and has been widely adopted as a hardy tree for landscapes and windbreaks. However, Russian-olive has also demonstrated the ability to escape cultivation and become a difficult-to-control weed.

Russian-olive is native to Eastern Europe and western Asia. The species arrived in the United States during colonial times and moved west with the early settlers. By the 1900's Russian-olive was present in most western states. Russian-olive's ability to thrive in arid environments has led to its widespread use for windbreaks and ornamental plantings throughout the West.

Soon after its introduction, Russian-olive began to escape cultivation and become weedy. The species is particularly suited to invade seasonally wet riparian habitats. In such areas, Russian-olive is highly competitive and can displace native vegetation, such as willows and cottonwoods. The fruit of Russian-olive can be used for food, but wildlife generally prefers to use native vegetation. Russian-olive branches often bear thorns that can interfere with the

movement of humans, livestock, and wildlife. Growth of the species along the banks of waterways can restrict water flow and increase soil erosion.

Description
Russian-olive's fast-growing, deciduous shrub or small tree that usually reaches 10 to 25 feet in height. Russian-olive forms a dense thicket when a number of plants are growing close together. Leaves are arranged alternately, 2 to 3 inches in length, and lanceolata with smooth margins. The upper leaf surface is green-gray while the lower surface and leaf stalks are silvery-gray. Foliage has an overall silvery appearance from tiny scales that cover the leaves. Branches are dark reddish-brown in color and usually have 1 to 2-inch woody thorns. Similar to the leaves, twigs are covered with scales that give a silvery-gray appearance. Flowers usually appear between May and June, and are yellow, bell-shaped, and arranged in clusters. Fruits are shaped like small olives and contain a single seed. Newly-formed fruits are silver but become tan or brown as they mature. Roots are deep and well-developed. Re-growth from crown or underground lateral roots is common in cut trees.

Habitat
Russian-olive thrives under a wide range of soil and moisture conditions. The plant readily survives periodic flooding and is drought tolerant. Russian-olive grows in many types of soil (e.g., sandy, silty, loamy), including sites with low fertility and high salinity.

Control Methods
Mechanical Control
Once established, control of Russian-olive is difficult. Live seeds persist in the soil for many years and disturbed plants can re-grow from lateral roots and other plant parts. The most effective and least expensive control tactic is to prevent establishment of the first plant. Not using Russian-olive as a landscape or ornamental tree prevents it from escaping into adjacent areas where it is not wanted. When new infestations of Russian-olive emerge, immediate application of control measures usually eradicates the stand before it can develop an extensive root system and persistent seedbank.

Several management practices are effective for controlling established stands of Russian-olive. Young plants/seedlings can be hand pulled in early spring when ground is moist. It is essential to get the entire root system when hand pulling. Saplings can be trimmed with a tractor-mounted mower, but must be repeated regularly. Mowing is a relatively simple operation and the results occur quickly. For large trees, top-growth can be removed with a chain saw. Russian-olive can re-sprout from cut stumps, twigs or branches. Cut material must be removed and destroyed. New sprouts that emerge from the cut stump or lateral roots should be pruned regularly.

Chemical Control
A number of herbicides and application techniques can be used to control Russian-olive. Cut-stump applications (herbicide applied to the stumps surface immediately after removing top-growth) are often successful. Effective herbicides contain triclopyr ester (Remedy®, Garlon® 4), triclopyr (Garlon® 3A), or imazapyr (Arsenal®, Habitat®). Triclopyr ester (a.i., 12.5%) with a penetrating oil, or 2,4-D + triclopyr (Crossbow®) can be applied as basal-bark treatments (herbicide applications made directly to the lower 2 feet of an uncut Russian-olive trunk). Finally, foliar applications of 2,4-D, glyphosate (Rodeo®, Roundup®, with a.i. of 20-

25%), triclopyr ester, 2,4-D + triclopyr, or imazapyr to fully expanded leaves and succeed if applied two to three times per year. Rodeo® and Habitat® are the only products that are both effective on Russian-olive and labeled for use in or around water.

Once mature plants are controlled, competition from desired plants is needed to suppress the re-establishment of Russian-olive. Establishing native plants, such as willow and cottonwood, can reduce the resources (i.e., light, water, and nutrients) available to Russian-olive and, thereby, suppress its establishment. Perennial understory species are also important competitors with new Russian-olive seedlings. Failure to establish adequate desirable vegetation allows Russian-olive and other weeds to rapidly re-invade the site.

No single control method or one-pass effort will successfully eliminate Russian-olive. The use of two or more control methods (integrated weed management) for several years is necessary. Permanent control will require many years of monitoring and treatment until the persistent seedbank has been exhausted and all buds on the root system have been completely killed.

Biological Control
At this time, no known biological control methods are reported for Russian olive.

Creeping Charlie (*Glechoma hederacea*)

Introduction
Creeping Charlie forms extensive mono-specific stands of up to 33% cover. This plant is toxic to many vertebrates, although palatable to numerous insects. Creeping Charlie is insect-pollinated (by bumblebees, honey bees, beetles and ants). Studies suggest strong allelopathic effects of Creeping Charlie on other species.

Creeping Charlie spreads primarily vegetatively; establishment from seed is probably rare in many habitats. Relatively few seeds are produced per plant (a maximum of four nutlets per flower and moderate flower production). Colonization by creeping Charlie likely follows openings created by plant mortality or disturbances caused by grazing animals. Seeds are passively dispersed as the calyx bends down at fruit maturation. Seeds may be further dispersed by ants. Nutlets produce mucilage on contact with water and can be fixed to various substrates. The germination of creeping Charlie increases after dry storage for at least one month at 68 degrees F. This species requires light for germination.

Creeping Charlie grows primarily on damp, heavy, fertile and calcareous soils with pH ranging from 5.5 to 7.5. It does not tolerate strongly acidic soils. It is also salinity intolerant. Creeping Charlie is partially shade tolerant.

In North America its range extends throughout the United States; it is naturalized in Canada and ranges from Newfoundland to British Columbia.

Description
Creeping Charlie is a perennial, evergreen and aromatic plant in the mint family. Plants can reach a height of 1 foot. Leaves are opposite, heart-shaped, 0.8 – 1.2 inches wide, petiolate and scalloped. Flowering occurs March to July, when tubular lavender flowers appear on the axils of the leaves. Flowers are typically 0.4 inches long and come in clusters of two or more. Creeping Charlie is native to Eurasia, and was introduced in the 1800s as an ornamental or medicinal plant.

Habitat
Creeping Charlie grows on shaded roadsides, waste areas, edges of pastures, arable fields, grasslands, cleared woodlands, and shrub lands. Although it is generally absent from aquatic habitats, it is occasionally found on river banks and floodplains.

Management
Once it is established the plant is difficult to control. It is impossible to dig out and remove all root and stolon fragments.

Control Methods
Mechanical Control
Small patches can be pulled or raked when the soil is damp. Removal of all roots is necessary to prevent re-sprouting.

Chemical Control
Glyphosate in monotypic areas; all leaves should be well covered. Fall applications of fertilizer containing 2, 4-D in lawn areas may be effective. Spot applicators of 2,4-D in combination with dicamba and mecoprop (MACPP) can be used when flowering or after the first hard fall frost. General use herbicide in weed and feed lawn fertilizers is effective. Broadleaf control used in coordination with other herbicides (slightly toxic).

Biological Control
At this time, no biological control methods are known for Creeping Charlie.

Honeysuckle (*Lonicera species*)

Introduction
The widespread distributions of bush honeysuckles are aided by birds, which consume the ripened fruit in summer and disperse the seeds over long distances. Seedlings establish in sparse vegetation, and are usually found growing under tall shrubs and trees.

Description
Honeysuckles are arching shrubs or twining vines, native to Eurasia. The leaves are opposite, simple oval, 1-10 centimeters long; most are deciduous but some are evergreen. Many of the species have sweet-scented, bell-shaped flowers that produce sweet, edible nectar that attracts hummingbirds. The fruit is a red, blue or black berry containing several seeds. In most species, the berries are mildly toxic.

Habitat
Honeysuckles can live in a broad range of habitats with varying moisture and shade levels. Most natural communities are susceptible to invasion by one or more of the species, with or without previous invasion. Woodlands are most affected, and are more vulnerable to invasion if disturbance occurs. Other habitats at risk for invasion include forest edges, roadsides, pastures, and abandoned fields. They can also be found in bogs, fens, and along lakeshores.

Control Methods
Mechanical Control
Since honeysuckle roots are fairly shallow, small- to medium-sized plants can often be dug or pulled. Plants are particularly easy to remove in spring when the soil is moist. A shovel or hoe will often loosen the roots enough to allow a fairly large plant to be pulled. In sensitive areas, they type of physical removal may disturb the soil and lead to more invasions, in which case it should be avoided. Soil should be tamped down to discourage further establishment of seedlings.

Chemical Control
Honeysuckles can be controlled by cutting the stems at the base with brush-cutters, chain saws or other tools. After cutting, stumps should be treated immediately with glyphosate using a backpack sprayer or wick applicator. Other New York State approved herbicide applications may also be appropriate (Table 3). Two cuts per year are recommended; one in early spring followed by one in early fall. Stumps must be treated with herbicide following cutting or vigorous re-sprouting will occur. Follow up treatments will be required.

Both mechanical and chemical control methods must be repeated for three to five years in order to prevent new seedlings from emerging. Re-invasion of honeysuckles may be prevented by seeding disturbed areas with tolerant native species.

Biological Control
At this time, no biological control methods are known for the honeysuckles.

Moneywort (*Lysimachia nummularia*)

Introduction
This plant is a native of Great Britain and much of Europe. It was first introduced as an ornamental. Although initially only widespread in the northeastern U.S. from Georgia to Maine, it now can be found into Canada, throughout the north-central states, and along the west coast. This rapidly growing perennial reproduces by seed as well as through a creeping growth habit of the stems. The stem creeps along the ground, rooting at each node when it gets the opportunity. Fruit is a globose capsule that opens longitudinally to expose the many seeds inside. Moneywort remains green throughout most of the year in Illinois.

Description
Moneywort is a low-growing herb with smooth stems that grow to 2 feet (61 cm) long, have a 0.05-0.1 inch (1.2-2.5 mm) diameter, and branch frequently to form a mat-like growth. The leaves are simple, have a short-petiole, and are opposite. The broadly oval leaves, which are obtuse at both ends, resemble small coins and give the plant its name. The 0.6-1 inch (17-25 mm) solitary flowers are wheel-shaped, 5-petaled, and are found in the leaf axils on a stalk as long as the leaves. The yellow flowers growing from the leaf bases are spotted with small dark red dots and bloom June to August. Moneywort should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

Habitat
Moneywort is most abundant in wet meadows, swamps, disturbed floodplain forests, and stream borders. It prefers moist, rich, shaded soils and is likely to be found in lawns, pastures, and along ditches and streams. Moneywort invades floodplain forests, wet and mesic prairies, marshes, and swamps. The plant tends to cover the ground with a mat of low-growing vegetation, excluding other herbaceous vegetation. Its ability to root at nodes enables it to cover larger areas.

Control Methods
Mechanical Control
Moneywort does not appear to be a problem in high-quality communities. In low wetland woods where it is invading, one possible means of control is by prescribed burning in spring or fall when moneywort is green but most native vegetation is dormant. The plant can be hand pulled where practical. All stems are green but most native vegetation is dormant. The plant can be pulled fro the area to prevent the stems from rooting again in the soil. Mowing is not effective sine moneywort adheres closely to the ground due to its many rooting nodes. In low-quality buffer areas, prolonged submergence will kill moneywort. At restoration sites, moneywort can be controlled by establishing native grasses to shade it out. Suggested grasses include reed grass (*Cinna arundinacea)* and Virginia wild rye (*Elymus virginicus)*. Seeding of native grasses should be used only at restoration sites and not at natural area.

Chemical Control
Herbicides such as Roundup or Rodeo may be effective control measures, but they have not been tested by many natural area managers.

Biological Control
No biological controls that are feasible in natural areas are known for moneywort.

Purple Loosestrife (*Lythrum salicaria*)

Introduction
Purple loosestrife displaces native wetland vegetation and degrades wildlife habitat. As native vegetation is displaced, rare plants are often the first species to disappear. Eventually, purple

loosestrife can overrun wetlands thousands of acres in size, and can almost eliminate the open water habitat.

Description
Purple loosestrife is an herbaceous perennial plant, which typically grows 1 to 1.5 meters tall, forming clonal colonies with numerous erect stems growing from a single woody root mass. The stems are reddish-purple and square in cross-section. The leaves are lanceolate, 3-10 centimeters long and 5-15 millimeters wide, downy and sessile, and opposite or in whorls of three. The flowers are reddish-purple, 10-20 millimeters in diameter, with six petals and 12 stamens. The flowers are clustered tightly in the axils of bracts or leaves. The fruit is a small capsule, 3-4 millimeters, containing numerous minute seeds.

Habitat
Purple loosestrife is a wetland plant, growing in shallow freshwater pond edges, fens, and marshes, on fertile, neutral to slightly alkaline soils.

Control Methods
Mechanical Control
This method includes cutting, pulling, digging and drowning. Cutting is best done just before plants begin flowering. Cutting too early encourages more flower stems to grow than before. If done too late, seeds may have already fallen. If no seeds are visible, bag all cuttings (to prevent them from rooting). If there is seed, cut off each top while carefully holding the plant upright, then bend it over into the bag to catch any seed that may drop.

Pulling and digging can be effective, but can also be disruptive by creating bare spots, which are good sites for reinvasion. Use these methods primarily with smaller plants in loose soils, since they do not leave large gaps, or root tips. Drowning young plants is effective if plants are completely submerged for one year.

Mowing has not been effective with loosestrife unless the plants can be mowed to a height where the remaining stems will be covered with water for a full 12 months. Prescribed burning has also proven to be ineffective. Mowing and flooding are not the recommended control method because they can contribute to further dispersal of seeds and stems.

Chemical Control
Chemical control is usually the most effective method to manage and eliminate loosestrife quickly, especially with mature plants. Herbicides should be applied in late July or August, before flowering to prevent seed set. The best method for chemical control is to cut stems and treat stump tops with herbicide. Currently, glyphosate is the most common chemical used (Table 3). If standing water is present, Aqua Neat, a glyphosate formulated and New York State listed for use over water should be used.

Another method is spot treatment in large areas that have desirable vegetation. This can reduce costs for sites with large densities, and reduce the amount of accidental spraying. Triclopyr is another herbicide that can be used as a foliar spray. It is formulated to use around water and does not affect grasses or sedges. Foliar application must cover nearly all of the foliage. Appendix C provides information on the potential herbicides that may be applied to control purple loosestrife.

Biological Control

Conventional control methods like hand pulling, cutting, flooding, herbicides, and plant competition have only been moderately effective on controlling purple loosestrife. Biocontrol is now considered the most viable option for more complete control for heavy infestations of purple loosestrife. A species of weevil, *Hylobius transversovittatus*, has been identified that lays eggs in the stem and upper root system of the plant; as larvae develop, they feed on root tissue.

In addition, two species of leaf-eating beetles (*Galerucella calmariensis* and *Galerucella pusilla*), and another weevil that feeds on the flowers (*Nanophyes marmoratus*) are being used to stress the plants in multiple ways. Research has shown that most of these insects are almost exclusively dependant on purple loosestrife and do not threaten native plants, although one species has shown some cross-over to native loosestrife. These insects will not eradicate populations, but may significantly reduce the size so cohabitation with native species becomes possible.

Integration of traditional controls and biocontrol may turn out to be the best plan for many sites, since some immediate loosestrife control can be maintained while biocontrol insects become established enough to exert meaningful control. The level of a species infestation can also provide for the appropriate response. For example, the Table below provides some general guidelines for implementing a particular management activity when differing densities of purple loosestrife are encountered in an area.

Purple Loosestrife Control
Size of Infested Area

	Isolated Plants	**Small** **Less than 1 acre** **(0.1 – 0.5 hectares)**	**Medium** **Up to 4 acres** **(0.5 – 2 hectares)**	**Large** **More than 4 acres** **(more than 2 hectares)**
Low Density **1 to 50 plants** **(1-25% of the area)**	Chemical control Digging and hand pulling	Chemical control Digging and hand pulling Cutting	Chemical control Digging and hand pulling Cutting	Chemical control Cutting
Medium Density **50 to 1,000 (25-75% of the area)**		Chemical control Digging and hand pulling Cutting	Chemical control Biological control Cutting	Biological control
High Density **More than 1,000** **(75-100% of the area)**		Chemical control Biological control Cutting	Biological control	Biological control

Sweet Clover (*Melilotus species*)

Introduction

Sweet clovers are fire-influenced, aggressive, weedy plants that produce populations with high rates of fluctuation. Both species degrade native grasslands by overtopping and shading native sun-loving species.

Description
Yellow and white sweet clovers appear very similar except for the flower colors. Yellow sweet clover is typically smaller than white sweet clover and blooms earlier. Sweet clovers are a biennial plant, which are vegetative the first year, and have a small branched stem with clover-like leaves. Leaves are divided into three finely toothed leaflets, with the middle leaflet occurring on a distinct stalk. The second year, plants appear more bush-like and can grow 3 to 5 feet tall. The flowers are densely packed on the upper four inches of an elongated stem.

Habitat
White and yellow sweet clover is found in all fifty states. Sweet clovers grow well in direct sunlight or partial shade. Neither species can tolerate dense shade. Sweet clovers are found more frequently in calcareous or loamy soils, and are most frequently found in open, disturbed, upland habitats such as savannas, prairies, and dunes.

Control Methods
Mechanical Control
Small amounts of sweet clover can be controlled by hand-pulling in late fall after first-year plant root crown buds have developed, or in May or June before second-year plants flower. Pulling is easier when the soil is wet. Plants can also be cut to ground level with loppers. If hand-pulling is done too early, many plants may be missed, and those with succulent stems may break off and re-sprout. But pulling must be done before seed set, otherwise cut plants will have to be removed from natural areas. For more densely populated areas, cutting with a brush saw is effective. The stand should be cut just before flowering, and checked a week later for missed or partially cut individuals.

Chemical Control
Spot foliar herbicide application to plants can be effective. Glyphosate is the preferred herbicide. Table 3 provides information on other potential chemical controls that may be applicable for sweet clover control.

Biological Control
The native sweet-clover weevil (*Sitona cylindricollis* Fahraeus), in high concentrations, can help control white and yellow sweet clover. Unfortunately, it is not a reliable control method at this time.

Reed Canary Grass (*Phalaris arundinacea*)

Introduction
Reed canary grass can rapidly invade a wetland. Invasion is usually associated with ditching of wetlands, stream channelization, and deforestation of swamp forests, sedimentation, and intentional planting. Over time, reed canary grass forms a large, monotypic stand that harbors few other plant species and are subsequently of little use to wildlife. Once established, reed canary grass dominates an area by building up a tremendous seed bank that can eventually erupt, germinate, and re-colonize treated sites.

Description
Reed canary grass is a large, coarse grass that can reach 2 to 9 feet in height. Is has an erect, hairless stem with gradually tapering leaf blades 3 ½ to 10 inches long and ¼ to ¾ inch wide. The blades are flat and have a rough texture on both sides. The compact panicles are erect or slightly spreading and range from 3 to 16 inches long. Single flowers occur in dense clusters in May to mid-June. They are green to purple and fade to beige in fall. The grass is one of the first to sprout in spring, forming a dense rhizome system that dominates the subsurface soil.

Habitat
Reed canary grass is a cool-season, sod-forming, perennial wetland grass native to Eurasia. This variety was selected and brought to the United States in the 1800s for forage and erosion control. Reed canary grass can grow on dry soils in upland habitats and in the partial shade of woodlands, but does best on fertile, moist organic soil in full sun. This species can invade most types of wetlands, including wet prairies, fens, marshes, sedge meadows, stream banks, and seasonally wet areas. It will also grow in disturbed areas such as spoil piles.

Control Methods
Mechanical Control
Small, discrete patches may be covered by black plastic for at least one growing season; the bare spot can then be reseeded with native species. This method is not always effective and must be monitored because rhizomes can spread beyond the edge of the plastic.

Mowing twice yearly (early to mid-June and early October) may help control reed canary grass by removing seed heads before the seed matures and exposing the ground to light, which promotes the growth of native wetland species. Discing the soil in combination with a mowing or burning regime may help by opening the soil to other species. Hand-pulling or digging may work on small stands in the early stages of invasion.

Chemical Control
A formulation of glyphosate designed for use in wetlands will kill reed canary grass when applied to foliage. Apply in early spring when most native plant species are dormant. Any herbicide application should be done only after removing dead vegetation from previous year in order to maximize exposure and minimize herbicide use. Table 3 provides information on several New York state approved herbicides that may be effective on reed canary grass.

While herbicide treatments kill actively growing plants, the seed bank may germinate and re-colonize the site. Several herbicide applications may be necessary to inhibit seed bank re-colonization. After the first application of herbicide has killed living plants, disturbance of the soil can encourage seed bank germination. When this occurs, the site can be treated again to deplete the seed bank.

An alternative method involves wick application of glyphosate in the early to mid-June, followed by an early to mid-July burn. This technique reduces reed canary grass coverage, depletes the seed bank, and stimulates native seed banks.

Biological Control
At this time, there are no known biological control methods for reed canary grass.

Common Reed Grass (*Phragmites australis*)

Introduction
Common reed grass has thick rhizomal growth and the accumulation of litter from aerial shoots prevents other species from becoming established. These monocultures have decreased value as wetland habitat for wildlife. Common reed is an undesirable species in areas where stands are spreading and overtaking the habitat, and species typical of the community are diminishing.

Description
Common reed grass is a tall, perennial grass that can grow to heights of 15 feet or more. Broad, pointed leaves develop from thick, vertical stalks. Leaves are 6 to 23 inches long, 0.4 to 2.4 inches wide, flat and glabrous. The flower heads are dense, fluffy, gray or purple in color, and 5.9 to 15.7 inches long. Flowering occurs from July to October.

Habitat
Common reed grass can be found in roadside ditches, open wetlands, river banks, lakeshores, disturbed or undisturbed areas. Common reed grass prefers alkaline and brackish waters but will tolerate highly acidic conditions. It can grow in water up to depths of 6 feet, and in somewhat dry areas.

Control Methods
Mechanical Control
Mechanical control methods for common reed grass can include mowing, disking, dredging, flooding, draining, and burning. Because common reed grass grows vegetatively, these methods can actually increase its spread.

Chemical Control
Studies have shown that the best control method for common reed grass is herbicide application. Apply glyphosate or Arsenal to the plant's foliage in late August through October, prior to the first frost (Table 3). Additional herbicide applications in subsequent years will be necessary to provide long-term control.

Biological Control
There are no known biological control methods at this time for common reed grass.

Common Buckthorn (*Rhamnus cathartica*)

Introduction
Once established, buckthorn has the potential to spread very aggressively in large numbers because it thrives in habitats ranging from full sun to shaded understory. Buckthorn species, most notably the common buckthorn and glossy buckthorn (*Rhamnus frangula*) cast a dense shade as they mature into tall shrubs. This shading has a particularly destructive effect on herbaceous and low shrub communities, and may prevent the establishment of tree seedlings.

Description
Common buckthorn is a tall shrub or small tree reaching 20 – 25 feet in height and 10 inches in diameter. Most often they grow in a large shrub form, having few to several stems from the base. The shrubs have spreading, loosely branched crowns. Their bark is gray to brown with prominent, often elongate, lighter-colored lenticels. Common buckthorn has dull green, ovate-elliptic leaves which are smooth on both surfaces and have minute teeth on the margins. They vary from rounded to pointed on the tip. Twigs of the common buckthorn often end in thorns.

Habitat
Common buckthorn originated in Eurasia and was introduced to North America as an ornamental species. It is a problem species mainly in the understory of woodlands, prairies, and savannas. It also occurs in thickets, hedgerows, pastures, abandoned fields, roadsides, and on rocky sites. It aggressively competes with local flora, mainly on well-drained soils.

Control Methods
Mechanical Control
Small patches of plants up to 0.4 inch diameter can be pulled when the soil is moist. Larger seedlings can be dug or pulled using a weed wrench. Disturbed soil will result from these techniques, and should be tamped down to minimize seeding. Girding or cutting stems between December and March may not be very effective unless followed by an application of herbicide.

Chemical Control
Chemical control methods re best done during the fall when most natives are dormant, yet buckthorn is still actively growing. This lessens the risk of affecting non-target plants. Control methods are also effective during the growing season, but pose a greater risk of affecting non-target plants, and the effectiveness of the treatment is generally lower. Winter application of chemicals has proven to be successful as well, and further lessons the risk of damaging non-target species. Table 3 provides a list of New York State approved herbicides routinely used to control non-native buckthorns.

During the growing season, cutting stems off near ground level and treating the cut stems with glyphosate successfully curbs sprouting. Immediately after cutting, herbicide should be applied to the stump. Re-sprouts should be cut and treated again, or sprayed with a foliar

application of herbicide such as Garlon 3A. Basal bark application of a Garlon solution also effectively controls buckthorn.

Biological Control
At this time, there are no known biological controls for buckthorns.

Multiflora Rose (*Rosa multiflora*)

Introduction
Multiflora rose is a medium height, thorny, bushy shrub with a more spreading than erect growth form. Leaves are born alternately on the stems and divided into 5-11 leaflets (usually 7-9). Each leaflet is broadly oval and toothed along its margin. Clusters of numerous white flowers, three-quarter to one and one-half inches (1.9-3.8 cm) across, bloom in late spring. The fruits are small, firm, red hips that may remain on the plant well into winter. Older rose shrubs may obtain a height of 15 feet (4.6 meters) or more with a root crown diameter of 8 inches (20 cm).

Multiflora rose can also be distinguished from most native roses by the fact that is styles are fused together into a column. The native roses, except prairie rose (*Rosa setigera*) have separate styles. Multiflora rose should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

Multiflora rose was originally introduced to the East Coast from Japan in 1886 as rootstock for cultivated roses. In the 1930's the U.S. Soil Conservation Service advocated use of multiflora rose in soil erosion control. Experimental plantings were conducted in Missouri and Illinois, and as recently as the late 1960's, many state conservation departments were distributing rooted cuttings to landowners. It was planted in the Midwest for living fences and soil conservation. Managers recognized that plantings of this thorny, bushy shrub provided excellent escape cover and a source of winter food for wildlife. The species soon spread and became a serious invader of agricultural lands, pastures, and natural communities from the Midwest to the East Coast.

Description
Multiflora rose is named for the clusters of many white flowers born on this perennial bramble during May or June. The flowers develop into small, hard fruits called hips that remain on the plant throughout winter. The great majority of plants develop from seeds remaining in the soil relatively close to plants from which they were produced. Birds and mammals also consume the hips and can disperse them greater distances. Rose seeds may remain viable in the soil for 10-20 years. Multiflora rose also spreads by layering, i.e., where tips of canes touch the ground and form roots, and by plants that arise from shallow roots. Multiflora rose readily invades prairies, savannas, open woodland, and forest edges. It is a thorny, bushy shrub that can form impenetrable thickets or "living fences" and smother out other vegetation. It is a serious pest species throughout the eastern United States.

Habitat

Multiflora rose occurs in successional fields, pastures, and roadsides. It also may occur in dense forests, particularly near natural disturbances such as tree fall gaps and along stream banks. It has a wide tolerance for soil, moisture, and light conditions; but it does not grow well in standing water.

Control Methods

Mechanical Control

Pulling, grubbing, or removing individual plants from the soil can only be effective when all roots are removed or when plants that develop subsequently from severed roots are destroyed. These approaches are most practical for light, scattered infestations. Research indicates that 3-6 cuttings or mowings per growing season for more than one year can achieve high plant mortality. Such treatment may need to be repeated for 2-4 years. Increased mowing rates (+6 per season) did not increase plant mortality. In high quality communities, repeated cutting is preferred over mowing, because repeated mowing will damage native vegetation as well as multiflora rose.

Prescribed Burning

In fire-adapted communities, a routine prescribed burn program will hinder invasion and establishment of multiflora rose.

Chemical Control

Cutting stems and either painting herbicide on the stump with a sponge applicator (sponge-type paint applicators can be used) or spraying herbicide on the stump with a low pressure hand-held sprayer kills root systems and prevents re-sprouting. Roundup herbicide (a formulation of glyphosate) has been effective in controlling multiflora rose when used as a 10-20% solution and applied directly to the cut stump. Although the Roundup label recommends a higher concentration for cut-stump treatment (50-100%), this lower concentration has proven effective. With this technique, herbicide is applied specifically to the target plant, reducing the possibilities of damaging nearby, and desirable vegetation. Cut-stump treatment is effective lat in the growing season (July-September), and also during the dormant season. Dormant season application is preferred because it will minimize potential harm to non-target species. Glyphosate is a nonselective herbicide, so care should be taken to avoid contacting non-target species. Both glyphosate and picloram (Tordon RTU) are recommended for controlling established plants.

In addition, Triclopyr (trade name Garlon 3A) can be applied to cut stems or canes for selective control of multiflora rose. Garlon 3A diluted in water at a rate of 50% can be sprayed, using a hand sprayer, to the cut surface. Application should be within minutes of cutting. Use of Garlon3A is best done in the dormant season to lessen damage to non-target species. Great care should be exercised to avoid getting any of the herbicided on the ground near the target plant since some non-target species may be harmed. Avoid using Triclopyr if rain is forecast for the following 1-4 days; otherwise runoff will harm non-target species. By law, herbicides may only be applied according to label directions.

Fosamine (trade name Krenite) can be applied as a foliar spray in a 2% solution plus 0.25% surfactant (two and one-half ounces of Krenite plus one-half ounce surfactant per gallon of water). The Krenite S formulation contains the appropriate amount of surfactant. Coverage

of foliage should be complete. Krenite should be applied only in July-September. No effects will be observed during the autumn season following application. Slight re-growth may occur the following season but canes will die during the summer. Fosamine kills only woody species and is non-volatile; therefore it is the preferred foliar spray treatment.

Dicamba (trade name Banvel) is an effective foliar spray that is less preferred than Krenite. Banvel is selective against broadleaf plants, so care must be taken to avoid contacting desirable, broadleaf vegetation. It can be applied as a foliar spray in a 1% solution (1 ounce of Banvel per gallon water). Though this solution can be applied any time during the growing season, best results are obtained during May and June when plants are actively growing and flowering, following, following full leaf-out. One-half ounce of a surfactant should be added when treating dense foliage and, to enhance control in late season applications, complete coverage of all green leaves should be achieved. Do not spray Krenite or Dicamba so heavily that herbicide drips off the target species. Foliar spray of herbicides should only be used in less sensitive areas because of problems with contacting non-target species.

Glyphosate (trade name Roundup) is an effective foliar spray when applied as a 1% solution to multiflora rose plants that are flowering or in bud. Roundup is not preferred chemical treatment, however, because it is non-selective and the selective herbicides mentioned above are effective. Nevertheless, Roundup can be used as a foliar spray during the growing season on severely disturbed sites if care is taken to avoid contacting non-target plants. Roundup should not be used as a foliar spray during the growing season in high-quality natural areas because it can be result in damage to non-target species. Roundup is useful as a foliar spry for alien plants that remain green and retain their leaves after native vegetation is dormant or senescent. Multiflora rose does not fit this description adequately and is controlled most effectively when treating during the growing season.

Biological Control

No effective biological controls that are currently considered feasible in natural communities are known. Rose rosette disease (RRD) is a fatal disease of multiflora rose and some cultivated roses, first described in the 1940s. The disease is caused by a virus-like particle transmitted by an eriophyid mite (*Phyllocoptes fructiphilus K.*). During past drought years, mite populations built up and RRD spread through much of the Midwest. The disease kills infected roses within two to three years and has already reduced weed populations in some areas. Pruning of multiflora rose will encourage succulent growth, which is more susceptible to mite infestation. Pruning may be practical in areas where RRD is present to encourage the spread of the disease. However, RRD may also infect native roses and plums, as well as commercially important plants in the rose family such as apples, some types of berries, and ornamental roses.

The rose seed chalid (*Megastigmu aculeastus* var. *nigroflavus*) a small wasp-like insect, imported from Japan, attacks developing seed of several rose species. By destroying large amounts of seed, the chalid limits new infestations. Research on the chalid impact on cultivated roses along with studies on environmental limitations is currently being conducted. Once more is known about the biology of these two control agents, RRD and the rose seed chalid could provide effective control of multiflora rose in areas where other methods are not feasible or

are undesirable. Vulnerable to defoliation by Japanese beetles Multiflora rose contains a substance (Geraniol) that attracts Japanese beetles.

Brambles (*Rubus species*)

Introduction
A number of native and introduced species of blackberries grow in the U.S. Wildlife and people eat berries produced by several species of brambles. However, vine growth can create problems where it grows vigorously, producing mounded thickets on pastures, Christmas trees plantations, ditches, and elsewhere.

Description
Rubus is a large genus of flowering plants in the family Rosaceae. Raspberries, blackberries, and dewberries are common, widely distributed members of the genus. Most of these plants have woody stems with thorns, spines, bristles, or hairs. The fruit is an aggregate drupelet. Blackberries, as well as other species, have mounding or rambling growth habitats. Raspberries, however, have an upright cane.

Habitat
Bramble habitat includes moist to slightly dry prairie edges along woodlands, thickets, open woodlands, savannas, woodland meadows, and fence rows, areas along roadsides and railroads, and abandoned pastures. This species prefers disturbed, burned-over areas in and around woodlands. It is a common invader of prairies.

Mechanical Control
Blackberry canes (stems) grow from underground burl-like root crowns. Where berry plants are few in number, they can be killed by grubbing out the burls with a mattock. Larger infestations away from fences or ditch banks can be disked out with repeated cultivations if the soil is not too wet. It may be necessary to burn out large thickets where appropriate before disking. Hand grubbing will be more effective after disking when new canes are forming. Blackberry vines are vigorous re-sprouts if the burls are not killed. Patience is required for successful control. Burning or mowing several years in a row (skipping a year may lead to their spread). Mowing followed by foliar herbicide treatment of re-sprouts triclopyr, glyphosate or metsulfuron-methyl.

Chemical Control
Complete coverage with foliar-applied herbicides of leaves, canes, and runners is necessary for maximum effectiveness. Care must be taken while applying herbicides to prevent overspray of non-target plants.

Biological Control
At this time, very little is known about biological control of brambles. Currently in Australia, blackberry rust (*Phragmidium violaceum*) is being tested in large areas of blackberry infestations. Further research is needed before this would be an acceptable control method.

Water Chestnut (*Trapa natans)*

Introduction
Water chestnut (*Trapa natans*) is also known as horned water chestnut or water caltrop. Water chestnut is an aquatic weed of the northeastern United States that can dominate ponds, shallow lakes, and river margins. It displaces native vegetation and limits navigation and recreation. It occurs from the northeast, west to the Great Lakes, and south to Washington, D.C.

Trapa natans was first observed in North America, growing "luxuriantly" in Sanders Lake, Schenectady, New York. The plant subsequently spread too many other areas in the northeastern United States including Connecticut, Delaware, Maryland, Massachusetts, New Hampshire, Pennsylvania, Vermont, Virginia, and Washington D.C.

Description
Trapa natans grows best in waters that are nutrient rich and moderately alkaline. It can grow in water up to 5m deep, but prefers shallow waters (0.3 to 2.0m deep). Where *T. natans* is abundant, up to 50 rosettes can grow in 1 m^2, which enables it to cover with water with up to three layers of leaves. Heavy shade from *T. natans* suppresses both submersed and other floating plants. The weed's extensive clonal propagation ability enables it to successfully colonize and monopolize aquatic habitats.

Trapa natans is an annual herb with a floating rosette of leaves around a central stem that is rooted in the hydrosoil. The spongy inflated leaf petioles enable the rosette to float. The plant produces new leaves from a central terminal meristem in the rosette near the surface of the water. The inconspicuous flowers are born in the leaf axils of younger leaves above the water. As the meristem elongates and produces new leaves, the older leaves and developing fruit move, in effect, down the stem and underwater. The single-seeded mature fruit are woody and bear four sharply pointed horns. When mature, the fruits fall from the plant and sink to the bottom of the water body. A seed dormancy period of four months has been found. The horns may act as anchors to limit the movement of the seed, keeping them in suitable depths of water. The seeds overwinter at the bottom of the water body, and germinate during, and throughout much of the warm season to produce shoots that grow to the water surface, where the typical rosette is formed. Seed can remain viable for up to five years.

Habitat
Water chestnut habitat in the United States includes lakes, ponds, slower sections of rivers and streams, and freshwater tidal estuaries. Preferred habitat is nutrient-rich water with a neutral to slightly alkaline pH.

Control Methods
This weed is difficult and expensive to control, and if unmanaged can dramatically increase. When the plant occupies a site, most recreational activities such as swimming, fishing from the shoreline, and the use of small boats are eliminated or severely impeded. The primary economic costs related to *T. natans* are associated with the costs of chemical and mechanical

control efforts. Vigorous management efforts by the U.S. Army Corps of Engineers during the 1950s and 1960s brought *T. natans* populations in the United States largely under control.

Mechanical Control
Removal of water chestnut through mechanical methods is recommended if infestations are larger. If smaller infestations or individual plants, removal can be by hand.

Chemical Control
2,4,-D is the only licensed chemical known to successfully control this species.

Biological Control
The specific geographic origins of the *T. natans* genotype(s) that has become a problem in the United States are unknown. The weed usually is thought to be from Eurasia but recent work considers it of Asian origin. The two regions surveyed for insect and pathogen natural enemies of *T. natans* are northeast Asia and Western Europe, which represent the eastern and western areas of the plant's temperature zone distribution. China, Japan, eastern Russia, and South Korea were surveyed in 1992 and 1993. These areas were selected because of previous records of damaging insects on wild populations of *Trapa* and published accounts of pest insects of cultivated Trapa in the region. Some of these natural enemies on *Trapa* occurred in areas with climates similar to those of the infested areas of North America. *Trapa natans* is a rare plant in Europe and the subject of conservation efforts to preserve and restore populations.

Among the insects found associated with *Trapa* species, the leaf beetle *Galerucella birmanica* Jacoby was the most common and damaging species found in Asia, causing complete defoliation of whole populations of plants. *Nymphuline pyralid* moths also were common and at times damaging. Both the beetle and the moths feed and develop on unrelated plants, so have no potential as *T. natans* biological control agents in North America.

Another unidentified *Nanophyes* species was found in the Harbin area of China and at Hinkanski in Russia. This weevil lays a single egg in the central vein of the upper side of the leaf blade. The newly hatched larva mines the central vine of the leaf blade downward into the petiole float where it finishes feeding and pupates. There is only one larva per leaf, and even though almost all leaves of some plants may be attacked, the leaves and plants remain normal and healthy. Adult feeding on the leaves is minor. The developmental periods (from egg to adult) for both of these weevils appear to be the same as the life span of a single leaf in which the development takes place, which is usually one to two weeks depending on the temperature. The eggs of both weevils are laid in young recently expanded leaves near the center of the rosette and the pupae of both species are found in old submerged leaves on the stem below the water's surface. This synchrony of weevil development with leaf age suggests extreme host specialization. *Nanophyes japonica* has not been recorded from plants other than *Trapa*, and it seems that both of these weevils are limited to *Trapa* species. They are the most specialized natural enemies of *Trapa* species found in northeast Asia.

Although *T. natans* continues to be a problem that requires expensive control efforts, no biological control research is being conducted at this time, but future research could help develop biological controls for the weed.

Narrow-leaved Cattail (*Typha angustifolia*)

Introduction
The acreage of cattail-dominated wetlands in the United States has increased drastically since the early twentieth century due to changes in hydrology and land use. Cattails can quickly dominate a wetland plant community and produce monotypic stands that reduce the overall habitat value.

Description
The narrow-leaved cattail leaves originate at the base of the stem, 1-3 meters high, and spread outward. Below ground, starchy rhizomes anchor the plant to the soil. The flower head, shaped like an elongated cylinder, is a compact spike at the terminal end of the stem. The flower spike is divided into two readily distinguished parts: pistillate flowers form a brown club located below the yellow spire of staminate flowers. If plants are growing in a colony, their rhizomes become intertwined and form a dense mat.

Habitat
Cattails can be found in damp soil or shallow water where sufficient nutrients are available. It is a common site along highways, in artificial ditches and shallow ponds, at the edges of calm waters, in wet patches of suburban yards, and in freshwater marshes.

Control
Mechanical Control
The control of cattails by the manipulation of water level must be timed to the annual cycle of carbohydrate storage. Special leaf and stem cells provide air passage from both living and dead leaves to the rhizomes. Removing dead leaves and submerging the shoots in early spring will strain the plant and eventually kill it. The depth of water necessary to kill the plant depends on temperature; the quantity of starch the plant stored the previous year, and the general vigor of the plants. Therefore, no minimum water depth can be prescribed, but generally, a water level maintained 3-4 feet above the tops of existing spring shoots will retard growth. The use of water is most efficient if the water level is progressively raised so that all plant parts remain submerged by no more than a few inches.

Starch reserves in the rhizomes are at the minimum in late spring when the pistillate spike of the cattail is lone green and the staminate is dark green. This is the best time to employ cutting, crushing, shearing, and/or discing to eliminate cattail colonies because all these methods impede starch storage during the growing season. Cutting, crushing, shearing, or discing severs the link that provides oxygen between the rhizomes and leaves of cattails during dormancy. These techniques must be combined with high springtime water levels in order to effectively retard plant growth. Bulldozers can effectively remove plants from a marsh area, but will drastically disturb the wetland.

Chemical Control
Application in mid to late summer enhances the effectiveness of translocated herbicides, although the herbicides will have little effect on seed production during the year of application. Table 3 provides information on potential herbicides for cattail control. Water

level control to minimize recruitment from the seed bank can be used to ensure cattails will not return once reduced by herbicides.

Biological Control
At this time, there are no known biological control methods for narrow-leaved cattail.

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Appendix C. NYSDEC Instructions for Applicator/Technician Pesticide Annual Report

New York State Department of Environmental Conservation

INSTRUCTIONS FOR APPLICATOR/TECHNICIAN PESTICIDE ANNUAL REPORT

Please read instructions before filling out forms. Questions? E-mail: prl@gw.dec.state.ny.us or call toll-free 1-888-457-0110. Reports must be typed or neatly printed. Reports that are not filed in accordance with these instructions will be rejected.

Reports are due by February 1 of the year immediately following the reporting year. Businesses may submit annual reports for all certified applicator and technician employees by recording one applicator or technician name and ID number on this form, along with all of the applications made by the business. **Then attach Form 44-15-26A listing all other applicator and technician names and ID Numbers as the top page of report.**

FILLING OUT THE REPORTING FORM

FOR EACH PESTICIDE APPLICATION, YOU MUST REPORT:

EPA REG. NUMBER - Report the EPA REG. NO. as it appears on the product label. **IMPORTANT:** Be sure to include the dashes and use the EPA REG. NO. and **NOT** the EPA EST. NO.

PRODUCT NAME - Report the registered product name, NOT the active ingredients.

QUANTITY USED - Report the amount of product used out of the manufacturer's container with the EPA REG. NO. on it. No fractions allowed, use only decimals. Extend two places to the right of the decimal, if necessary (i.e., ¾ = 0.75).

UNITS - Report the unit of measure applicable to the quantity used. **(Use only the following abbreviations: GL=Gallons, QT=Quarts, FL=Fluid Ounces, LB=Pounds, OZ=Dry Ounces, L=Liters, ML-Milliliters, KG=Kilograms, GM=Grams, MG=Milligrams)**

DATE APPLIED - Enter the date in the following format (MMDD): 0101 = January 1; 1114 = November 14.

COUNTY CODE - Report the county where the pesticide was applied. (Use the county codes listed on back)

ADDRESS - Enter street address where pesticide was applied.

MUNICIPALITY - Enter village, city, etc., where pesticide was applied.

ZIP CODE - Report five-digit zip code where pesticide was applied.

THIS INFORMATION MUST BE SENT TO NYSDEC BY FEBRUARY 1.

NOTE: Use of ditto marks, arrows, or the word "same" is permitted for repetitive information. See sample below:

SAMPLE:

EPA REG. NUMBER	PRODUCT NAME	QUANTITY USED	UNITS	DATE OF APPL.	COUNTY CODE	ADDRESS	MUNICIPALITY (CITY, VILLAGE, ETC)	ZIP CODE
264-335-572	Sevin SL	2.33	FL	1220	05	1344 East Swan Street	Locke	13092
" "	" "	"	"	"	11	5 Main Street	Homer	13077
123-4576	Weed X	6	ML	0909	05	87 Johnston Lane	Locke	13092
3125-372	Tempo 2	8	"	0910	↓	↓	↓	↓
264-335-572	Sevin SL	2.33	FL	0911	↓	↓	↓	↓

MAIL COMPLETED FORMS TO:

Pesticide Reporting Section
NYSDEC
PO Box 10699
Albany, NY 12201-5699

FILLING OUT THE RECORD KEEPING FORM
(FOUND ON BACK OF REPORT FORM)

DOSAGE RATE - Enter the amount of pesticide used for a given application; e.g., 1 fluid ounce/gallon (FL/G); 1 gram/12 inches (GM/IN), etc. (This is the premix or final mix dosage rate listed on the pesticide label.)

METHOD OF APPLICATION - Method used to apply the pesticide (broadcast, hand placement, aerial, etc.)

TARGET ORGANISM(S) - Enter the name of the targeted pest(s). The targeted pest or organism must be listed on the pesticide label.

PLACE OF APPLICATION - Enter location where the pesticide was applied (greens 3 & 7 of golf course; front lawn area, restaurant kitchen, etc.)

THIS INFORMATION SHOULD NOT BE SENT TO NYSDEC, BUT MAY BE USED TO MEET RECORD KEEPING REQUIREMENTS.

COUNTY CODES

County	Code	County	Code	County	Code
Albany	01	Jefferson	22	Schoharie	43
Allegany	02	Lewis	23	Schuyler	44
Broome	03	Livingston	24	Seneca	45
Cattaraugus	04	Madison	25	Steuben	46
Cayuga	05	Monroe	26	Suffolk	47
Chautauqua	06	Montgomery	27	Sullivan	48
Chemung	07	Nassau	28	Tioga	49
Chenango	08	Niagara	29	Tompkins	50
Clinton	09	Oneida	30	Ulster	51
Columbia	10	Onondaga	31	Warren	52
Cortland	11	Ontario	32	Washington	53
Delaware	12	Orange	33	Wayne	54
Dutchess	13	Orleans	34	Westchester	55
Erie	14	Oswego	35	Wyoming	56
Essex	15	Otsego	36	Yates	57
Franklin	16	Putnam	37	Bronx	58
Fulton	17	Rensselaer	38	Kings	59
Genesee	18	Rockland	39	New York	60
Greene	19	St. Lawrence	40	Queens	61
Hamilton	20	Saratoga	41	Richmond	62
Herkimer	21	Schenectady	42		

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APPLICATOR/TECHNICIAN PESTICIDE ANNUAL REPORT

Report Year	Certification ID Number	Applicator/Technician Last Name	Applicator/Technician First Name	Bus./Agency Reg. No. (If applicable)
	C			

☐ Check Here If No Commercial Applications Were Conducted This Year

Row #	Col. 1 EPA REG. NUMBER	Col. 2 PRODUCT NAME	Col. 3 QUANTITY USED	Col. 4 UNITS	Col. 5 DATE OF APPL.	Col. 6 COUNTY CODE	Col. 7 ADDRESS	Col. 8 MUNICIPALITY (CITY, VILLAGE, ETC.)	Col. 9 ZIP CODE
1									
2									
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6									
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14									
15									

USE (07/03)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF SOLID AND HAZARDOUS MATERIALS ● BUREAU OF PESTICIDES MANAGEMENT
www.dec.state.ny.us

PESTICIDE APPLICATOR/BUSINESS/USE INSPECTIONS

INSPECTION NUMBER	FIRM/FACILITY/PERSON INTERVIEWED	EQUIPMENT TYPE/SIZE
TYPE OF INSPECTION: [ ] Business/Agency [ ] Applicator [ ] Non-agricultural use [ ] Agricultural use	SITE OF INSPECTION	
BUSINESS REG. NO./EXPIRATION DATE	INSURANCE COMPANY/EXPIRATION DATE	

APPLICATOR NAME/CERTIFICATION TYPE	CERTIFICATION ID	CATEGORY/EXPIRATION	SUPERVISED BY

DATE/TIME/WEATHER CONDITIONS DURING APPLICATION	CROP	SITE/SIZE	TARGET PESTS

PESTICIDE NAME/EPA REG NO.	METHOD OF APPLICATION	CLASSIFICATION	FORMULATION	LABEL RATE	OBSERVED RATE

LABEL/EQUIPMENT REQUIREMENTS	REFERENCE SECTION	Yes	No	NA
Label Rate Followed	325.2(b)			
Target Pests on Label	325.2(b)			
PPE/Cautionary Labeling Followed	325.2(b)			
Preharvest Interval/REI per Label	325.2(b)			
Crop/Area Treated per Label	325.2(b)			
Pesticide Containers Properly Labeled	33.1301(1)(b)			
Service Containers Properly Labeled	33.1301(1)(b)			
Containers Properly Rinsed and Disposed	325.4(a)			
Backflow Prevention/Air Gap Present	325.2(c)			
Proper Stickers on Equipment/Vehicles	325.26			
Equipment Properly Calibrated				
Storage Locked/Containers Secure				
Warning Signs Posted				
Location of Container Disposal:				
Location of Pesticide Storage:				
Water Source:				
Pesticide Mixing Area:				

APPLICATOR REQUIREMENTS	REFERENCE SECTION	Yes	No	NA
Apprentices Properly Supervised	325.7(d)			
Apprentices Trained/Documented	325.10(a)			
Apprentice Variance Approved	325.10(b)			
I. D. Card in Possession During Use	325.7(a)			
Label in Possession During Use	325.2(d)			
Notification Requirements Met	33-0905(5)			
REPORTS/RECORDS	33-1205(1)	Yes	No	NA
EPA Reg. No.				
Product Name				
Quantity				
Date Applied				
Address				
Place of Application				
Dosage Rate				
Method of Application				
Target Organism/Crop Treated				
Records Kept 3 Years				

REMARKS:

INSPECTOR'S SIGNATURE

DATE AND TIME INSPECTED

Pesticide Storage Checklist

Inspect your pesticide storage area regularly. If you answer "no" to any statements below, take immediate steps to correct the situation.

Date of Inspection: _____ _____ _____

Safety	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Storage room locked.	☐	☐	☐	☐	☐	☐
Storage area signs posted with emergency contact information.	☐	☐	☐	☐	☐	☐
No Smoking signs posted.	☐	☐	☐	☐	☐	☐
Personal protective equipment stored nearby.	☐	☐	☐	☐	☐	☐
Clean up supplies stored nearby.	☐	☐	☐	☐	☐	☐
Inventory is up to date and stored separately.	☐	☐	☐	☐	☐	☐
Labels and MSDS on file.	☐	☐	☐	☐	☐	☐
Fire extinguisher in good working order.	☐	☐	☐	☐	☐	☐
Storage Area						
Ventilation system is working.	☐	☐	☐	☐	☐	☐
Area is clean with no debris or combustibles.	☐	☐	☐	☐	☐	☐
Floor is clear of spills or leaks.	☐	☐	☐	☐	☐	☐
Pesticides stored off floor	☐	☐	☐	☐	☐	☐
Storage area contains pesticides only--no feed, fertilizer or other materials.	☐	☐	☐	☐	☐	☐
Container Inspection						
Labels readable and attached to containers.	☐	☐	☐	☐	☐	☐
Containers marked with purchase date.	☐	☐	☐	☐	☐	☐
Insecticides, herbicides, and fungicides stored separately.	☐	☐	☐	☐	☐	☐
Dry formulations stored separately or above liquid containers.	☐	☐	☐	☐	☐	☐
Container caps are tightly closed.	☐	☐	☐	☐	☐	☐
Used containers are rinsed and punctured.	☐	☐	☐	☐	☐	☐

Adapted from "Pesticides and Their Proper Storage", Purdue Pesticide Programs, PPP-26

APPENDIX D. MANAGEMENT SPECIFICATIONS

SECTION 31 13 13

SELECTIVE WOODY BRUSH REMOVAL

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the selective cutting and disposal of woody brush including trees and shrubs, as necessary for construction of the Albany Landfill mitigation project, complete in all respects. This section documents methods also presented in the Integrated Pest and Invasive Species Management Plan for this project.

B. Related Sections:
1. Section 31 13 14 – Herbaceous Species Removal
2. Section 32 92 19 – Seeding
3. Section 32 93 13 – Perennial Plantings

1.2 REGULATORY REQUIREMENTS

A. Perform all work in accordance with applicable Federal and State wetlands regulations

1.3 QUALITY ASSURANCE

A. Provide at least one person during execution of this portion of the work that shall be thoroughly familiar with this type of work, means and methods, and the type of materials being used. Said person shall be competent at identification of plant materials to be cut and to be preserved during the season work is to be completed. Said person shall also direct the work performed under this section.

B. All materials used during this portion of the work shall meet or exceed applicable federal, state, county and local laws and regulations. The use of any herbicide shall follow directions given on the herbicide label. In the case of a discrepancy between these specifications and the herbicide label, the label shall prevail.

1.4 SUBMITTALS

A. Materials: Prior to delivery of any materials to the site, submit to the OWNER a complete list of all materials to be used during this portion of the work. Include complete data on source, amount and quality. This submittal shall in no way be construed as permitting substitution for specific items described on the plans or in these specifications unless approved in writing by the OWNER'S REPRESENTATIVE.

B. Licenses: Prior to any herbicide use the CONTRACTOR shall submit to the OWNER a current copy of the appropriate State of New York pesticide applicator's license for each person who will be applying herbicide at the project site. A copy of each pesticide

applicator's license must be maintained on site at all times during completion of the work.

C. Equipment: Prior to commencement of any work, submit to the OWNER a written description of all mechanical equipment and its intended use during the execution of the work.

D. Permits: Prescribed burning will not be permitted without the prior written approval of the OWNER. If prescribed burning is permitted, prior to the commencement of any prescribed burning, the CONTRACTOR shall submit copies of all required open burn permits to the OWNER.

PART 2- PRODUCTS

1.5 MATERIALS

A. Herbicide to be used for basal applications shall be triclopyr: 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester, trade name Garlon 4 or equivalent as approved in writing by the OWNER.

B. Herbicide to be used for foliar applications shall be triclopyr: 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester, trade name Garlon 3 or equivalent as approved in writing by OWNER.

PART 2 - EXECUTION

2.1 GENERAL

A. The CONTRACTOR will cut all woody species designated for removal with hand tools including, but not necessarily limited to, gas-powered chain saws, gas-powered clearing saws, bow saws, and loppers.

B. All stumps shall be cut flat with no sharp points, and to within two inches of surrounding grade.

C. Removal of undesirable woody species shall preferentially occur when the ground is frozen. Vegetation removal at times other than the winter season, from November 1 through March 14, is prohibited without the prior written approval of the OWNER. The OWNER shall grant such approval only if consistent with the provisions of the permits referenced in Section 1.2.

D. Stumps shall be left in the ground and not removed. All stumps shall be treated with an approved herbicide mixed with a marking dye.

E. Girdling may also be used in combination with cutting and stump herbicide treatment if approved in writing by the OWNER. Trees to be girdled shall have a one inch deep notch cut completely around the trunk approximately 36" above surrounding grade. A basal application of an approved herbicide shall also be used following label directions.

F. All brush shall be removed from the entire work area and disposed of by the OWNER or CONTRACTOR in accordance with all applicable laws and regulations.

G. A supply of chemical absorbent shall be maintained at the project site. Any chemical spills shall be properly cleaned up and reported to the OWNER within 24 hours.

H. The CONTRACTOR shall maintain copies at the project site of all current pesticide applicator's licenses, herbicide labels, and MSDS's (Material Safety Data Sheets) for all chemicals utilized during completion of the work.

I. Species designated for removal are:

COMMON NAME	**SCIENTIFIC NAME**	**DISPOSITION**
Amur Honeysuckle	*Lonicera maackii*	Remove all
Black locust	*Robinia pseudoacacia*	Remove all
Box elder	*Acer negundo*	Remove all
Common buckthorn	*Rhamnus cathartica*	Remove all
Elms	*Ulmus* spp	As necessary
Green ash	*Fraxinus pennsylvanica subintegerrima*	As necessary
Multiflora Rose	*Rosa multiflora*	Remove all
Native shrubs		As necessary
Red maple	*Acer rubrum*	As necessary
Russian Olive	*Elaegnus angustifolia*	Remove all
Tartarian Honeysuckle	*Lonicera tatarica*	Remove all

2.2 CLEAN-UP, REMOVAL, AND REPAIR

A. Clean up: The work area shall be kept free of debris by the CONTRACTOR. At no time shall empty herbicide containers, trash, or other material be allowed to accumulate at the project site. All tools shall be kept in appropriate carrying cases, tool boxes, etc. Parking areas, roads, sidewalks, paths and paved areas shall be kept free of mud and dirt.

B. Removal: After work has been completed remove tools, empty containers, and all other debris generated by the CONTRACTOR and properly dispose of all waste and empty containers.

C. Repair: Repair any damages caused by the CONTRACTOR during completion of the work described in this Section. Said damages may include, but are not limited to, tire ruts in the ground, damage to vegetation outside of the prescribed work limits, etc. In the event any vegetation designated to be preserved is damaged, notify the OWNER within 24 hours. The CONTRACTOR shall be liable for remedying said damages to plant materials, at no additional cost to the OWNER.

2.3 INSPECTION

A. After completion of selective woody brush removal, the CONTRACTOR shall schedule with the OWNER a provisional acceptance inspection of the work.

B. After provisional acceptance of selective woody brush removal, the CONTRACTOR shall conduct an inspection of work areas one year following provisional acceptance. Within five business days of the inspection, the CONTRACTOR shall notify the OWNER in writing of the results of the inspection, and noting any stumps that have re-sprouted.

END OF SECTION

SECTION 31 13 14

HERBACEOUS SPECIES REMOVAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section includes the eradication of herbaceous species, including grasses and forbs, as required for construction of the Albany Landfill mitigation project, complete in all respects, as shown on the drawings and as required by these specifications. This section documents methods also presented in the Integrated Pest and Invasive Species Management Plan for this project.

B. RELATED SECTIONS

1. Section 32 91 13 – Soil Preparation
2. Section 32 92 19 – Seeding
3. Section 32 93 13 – Perennial Plantings

1.3 QUALITY ASSURANCE

A. Qualifications of workmen: Provide at least one person during execution of this portion of the work that shall be thoroughly familiar with this type of work, means and methods, and the type of materials being used. Said person shall be competent at identification of plant materials to be removed and to be preserved during the season (summer, winter) work is to be completed. Said person shall direct the work performed under this section.

B. Standards: All materials used during this portion of the work shall meet or exceed applicable federal, state, county and local laws and regulations. The use of any herbicide shall follow directions given on the herbicide label. In the case of a discrepancy between these specifications and the herbicide label, the label shall prevail.

1.4 SUBMITTALS

A. Materials: Prior to delivery of any materials to the site, submit to the OWNER a complete list of all materials to be used during this portion of the work. Include complete data on source, amount and quality. This submittal shall in no way be construed as permitting substitution for specific items described on the plans or in these specifications unless approved in writing by the OWNER'S REPRESENTATIVE.

B. Licenses: Prior to any herbicide use the Contractor shall submit to the OWNER a current copy of the appropriate State of New York pesticide applicator's license for each person who will be applying herbicide at the project site. A copy of each pesticide applicator's license must be maintained on site at all times during completion of the work.

C. Equipment: Prior to commencement of any work, submit to the OWNER a written description of all mechanical equipment and its intended use during the execution of the work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Herbaceous species to be removed in areas without standing water or saturated soils shall be treated with Glyphosate, N-(phosphonomethyl) Glycine, trade name Roundup or equivalent as approved in writing by OWNER.

B. Herbaceous species to be removed in areas with standing water or saturated soils shall be treated with Glyphosate, N-(phosphonomethyl) Glycine in a form approved for aquatic applications such as Rodeo or equivalent as approved in writing by OWNER.

C. Selective grass herbicides and other specialty herbicides may also be used in appropriate locations, but only with the prior written approval of the OWNER. For any materials not specifically called for herein, CONTRACTOR shall submit complete identifying information including manufacturer's literature, manufacturer's recommendations for use, restrictions on use, MSDS, and any other information requested by the OWNER. Alternatives to specified materials will not be used in the work unless approved by the OWNER in writing.

PART 3 - EXECUTION

3.1 METHOD

A. The CONTRACTOR will treat all vegetation within targeted areas with an approved herbicide. Herbicide application instructions given on the label shall be followed at all times.

B. Targeted areas will be located in the field by the OWNER. Contractor shall not proceed with any herbaceous species removal until the areas of the work have been clearly identified and marked.

C. Care shall be taken not to affect vegetation outside of target areas. If areas outside the limits of work are affected, such areas shall be restored in kind at no additional cost to the OWNER.

D. A supply of chemical absorbent shall be maintained at the project site. Any chemical spills shall be properly cleaned up and reported to the Owner within 24 hours.

E. The CONTRACTOR shall maintain copies at the project site of all current pesticide applicator's licenses, herbicide labels, and MSDS's (Material Safety Data Sheets) for all chemicals utilized during completion of the work.

F. Herbicide may be applied using a backpack sprayer, a hand-held wick applicator, or a vehicle mounted high pressure spray unit.

3.2 CLEAN-UP, REMOVAL AND REPAIR

A. Clean up: The work area shall be kept free of debris by the CONTRACTOR. At no time shall empty herbicide containers, trash, or other material be allowed to accumulate at the project site. All tools shall be kept in appropriate carrying cases, tool boxes, etc. Parking areas, roads, sidewalks, paths and paved areas shall be kept free of mud and dirt.

B. Removal: After work has been completed remove tools, empty containers, and all other debris generated by the CONTRACTOR and properly dispose of all waste and empty containers.

C. Repair: Repair any damages caused by the Contractor during completion of the work described in this Section. Said damages may include, but are not limited to, tire ruts in the ground, damage to vegetation outside of the prescribed work limits, etc. In the event any vegetation designated to be preserved is damaged, notify the OWNER within 24 hours. The Contractor shall be liable for remedying said damages to plant materials, at no additional cost to the OWNER.

3.3 INSPECTION

After completion of herbaceous species removal, the Contractor shall schedule with the OWNER a provisional acceptance inspection of the work.

END OF SECTION

SECTION 32 94 50

LANDSCAPE MAINTENANCE PERIOD

PART 1. GENERAL

1.1 SUMMARY

A. This Section Includes the management activities for maintaining the native plant communities created, restored and enhanced on the Albany Rapp Road Landfill Property.

B. Related Sections:
1. Section 32 91 13 -- Soil Preparation
2. Section 32 92 19 -- Native Plant Seeding
3. Section 32 93 13 -- Perennial Plantings
4. Section 32 93 43 -- Trees and Shrubs

1.2. REGULATORY REQUIREMENTS:

A. Perform all work in accordance with applicable Federal and State wetland regulations.

1.3 QUALITY ASSURANCE

A. Contractor Qualifications:
1. Maintenance Management CONTRACTOR: Minimum 10 years experience in maintenance of similar landscape projects.

2. Maintenance Supervisor: Minimum of 10 years experience in landscape maintenance supervision, with experience or training in prairie management, entomology, pest control, soils, fertilizers and plant identification.

3. Labor Force: Familiar with and trained in the work to be accomplished and perform the task in a competent, efficient manner acceptable to the Owner. All laborers applying herbicide must have commercial herbicide applicators license.

4. Supervision: The Project Superintendent shall directly employ and supervise the work force.

5. Notification of Change in Supervision: Notify OWNER of changes in supervision.

6. Identification: Provide proper identification for landscape firm's labor force.

PART 2 PRODUCTS

2.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Labeling: Furnish standard products in unopened manufacturer's standard containers bearing original labels showing quantity, analysis and name of manufacturer.

B. Storage: Store products with protection from weather or other conditions, which would damage or impair the effectiveness of the product. Products requiring state permits or licensing, such as herbicides, will be stored in an approved facility in compliance with applicable laws and regulations.

C. Handling: Do not lift or handle container plants by tops, stems or trunks at any time. Do not bind or handle plants with wire or rope at any time.

D. Anti-Desiccant: At contractor's option, spray evergreen or deciduous plant material in full leaf immediately before transporting with anti-desiccant. Apply an adequate film over trunks, branches, twigs and foliage.

E. Digging: Dig ball and burlap (B & B) plants with firm, natural balls of earth of diameter meeting requirements of ANSI Z60.1, and of sufficient depth to include the fibrous and feeding rots.

2.2 SEQUENCING AND SCHEDULING

A. Work Schedule:

1. Work Hours: Perform maintenance during hours accepted by OWNER.

2. Maintenance: Work force shall be present at the project site at least once per month during the first year's growing season for observation and/or as often as necessary to perform specified maintenance in accordance with the accepted maintenance schedule.

2.3 MATERIALS

A. Herbicides, Insecticides, and Fungicides: Legal commercial quality non-staining materials with original manufacturers' containers, properly labeled with guaranteed analysis, as recommended by licensed applicators and ecologist.

PART 3. EXECUTION

3.1 GENERAL

A. Protection of Existing Conditions:

1. General: Use every possible precaution to prevent damage to existing conditions to remain such as structures, utilities, plant materials and walks on or adjacent to the site of the work.

2. Barriers: Provide barricades, fences or other barriers as necessary to protect existing conditions from damage during maintenance operations.

3. Hazardous Operations: Do not store materials or equipment, does not allow burning, or operate or park equipment under the branches of existing plants.

4. Notification: Give written notification of damaged plants and structures.

5. Replacement of plant material: Replace existing plants which are damaged during maintenance with plants of the same species and size as those damaged at no cost to the OWNER.

3.2 MAINTENANCE PERIOD

A. The maintenance requirements are also discussed in section 2.1 of the Monitoring Plan and Performance Criteria in Appendix 3, where the first 10 year period following seeding and planting is referred to as the short-term and long-term management periods.

1. The maintenance period shall be 10 years. First year of maintenance shall be the year when substantial seeding and planting has been completed and trees and shrub installed. Currently the tentative year for beginning the ten years of maintenance is 2010 for the first phase of the restoration plan (see plan set). Subsequent phases will have different maintenance start and end dates, commensurate with this ten year period of time. This is contingent on the construction schedule and substantial completion of the seeding and planting. Ongoing maintenance as necessary during the construction phase will also occur. Table 1 provides a ten-year restoration, management and monitoring schedule for this project. Proposed quarterly dates for restoration tasks are target dates. Adjustments to these dates will need to be made to address site needs and responses to adaptive management.

3.3 GRASSES AND WILDFLOWERS MAINTENANCE AND MANAGEMENT

A. Mowing:

1. Prior to mowing install highly visible flags outlining zones to be mowed.

2. Mowing shall be required if weed cover is determined to be a problem for establishment of native grasses and wildflowers. Ecologist will determine if and when mowing will be required. Mowing, direct plant herbicide application, and hand pulling are the primary methods of weed control to be dexercised. Mowing to a height of 8-10 inches in mid June-July may be conducted during years 1-3 in all upland planting sites. Mowing will be authorized annually as necessary. It is anticipated that 1-2 times annually will be required at the recommendation by the Ecologist. The contractor performing the native areas weed management is to supply the Ecologist with a letter report on weed control efforts performed from July through September of each year.

3. Use a rotary type mower to prevent creation of mats of clippings.

4. Use appropriate low profile equipment for slope conditions to minimize the damage to soils and vegetation.

5. Do not mow shorter than 6-8 inch height, unless written approval from Ecologist.

B. Noxious Weed Management:

1. Control of plants deemed to be undesirable (either listed as noxious weeds, or undesirable because of ecological characteristics that create or effect undesirable outcomes in the native species landscaping) by the Ecologist shall be conducted by the landscape contractor. Roundup or equivalent applied by wick treatment may be required annually for the 10-year period.

2. Ecologist will determine if and when approved herbicide application is required.

C. Brush Management:

1. Restored wetlands that are invaded by non-native shrub and invasive tree species shall be brushed by cutting stems close to ground level and herbiciding cut stems with an approved herbicide to reduce and remove these shrubs and trees. All non-native trees and shrubs will be removed and up to 50% of native invasive trees, such as box elder.

2. Trees and shrubs to be cut, will be field flagged by project ecologist and zones mapped. Cut trees and shrubs shall be cut and dropped on site or chipped. Chips may be removed and properly disposed of, or reused as mulch on site as determined by the project ecologist. Some trees and shrubs may be left standing and basal bark treated at the direction of project ecologist.

3. All cut stumps shall be treated by a certified and licensed herbicide applicator with the herbicides Roundup, Garlon 4A or a suitable substitute. For control of invading woody vegetation, treating stumps and girdles and foliar or wick apply plants using the following methods: a) Application of Garlon 4 will follow the "cut stump treatment" listed on the label using 30 gallons of Garlon 4 to make 100 gallons of equivalent spray mixture, or b) Use a 40% solution of Garlon 4 and 40% Tordon 101 mixed with 20% basal oil, or, c).

4. Brushing work performed in regulated wetlands shall be conducted during late fall (Nov. 2) to late winter (March 14).

5. Performance required for acceptance is that 90% of cut and herbicided stumps have no evidence of re-sprouting or re-growth 1 year after treatment.

6. Any tree or shrub species to not be cut and treated shall be field flagged by the project Ecologist.

D. Forest and Shrub Plantings

1. The reforestation and restoration plantings may need to be maintained against damage from the following problems:
   a. Deer browsing damage.
   b. Rabbit and mouse girdling damage.
   c. Goose browsing
   d. Disease and insect infestation.

2. Herbivore browsing damage to tree and shrubs require preventative strategies. These include appropriate stem wraps, and other techniques as necessary to allow trees and shrubs to continue normal growth and development.

3. Disease and insect infestations that may threaten tree and shrub will be addressed during the initial 10-year establishment period. Integrated pest control management techniques including use of strategies allowed by USDA, Forest Service and State Agricultural extension will be the preferred methods on the project site.

E. Herbicide Application

1. Applying the herbicide will be done as to conform with all Federal, State and local regulations and label guidelines and by trained licensed applicators. Use listed product label mixes as specified unless options call for varied approved mixes. Use Roundup in a 50:50 mix, or, d) Use Rodeo in a 50:50 mix for use in or near aquatic systems wetlands.

2. Herbicide can be applied: a) with sponges to prevent the herbicide from coming into contact with the ground or other existing vegetation (a heavy duty floor sponge is recommended). A sponge applicator is effective on stem densities of 1" and less. The cut surface of the stump the sides and are treated thoroughly, but not to the point of runoff, or, b) use an extremely low pressure manual sprayer to apply the herbicide to the cut surface of the stump and the sides of the stump and root collar, until thoroughly wet, but not to the point of runoff, or, c) Use fine mist application spray as a foliar spray. Other methods, proposed by the herbicide contractor, must be approved by the project ecologist.

3. Herbicide mixture needs to be applied completed around the entire cambium layer of the cut stump or girdle.

4. Treatment shall be done within 2 hours of cutting the brush or trees and before any mud or dirt gets onto the cut surface.

5. Use adequate dye to provide visual record of treated stumps to avoid untreated stumps.

6. All herbicide shall be mixed and filled according to the following requirements:

A. An applicable tracer colorant shall be used in all chemical mixes. The contractor shall inform the Owner of the color to be used.

B. Filling of containers or mixing of herbicides shall be done at a point away from any natural area, trees, shrubs, herbaceous, woody growth or body of water.

C. A tarp beneath a cutoff 55-gallon plastic drum (or similar device) shall be utilized to guard against any spills being leaked onto the ground. All mixing shall be done in or directly above the drum. The method for spill prevention must be approved by the Owner.

D. Cleaning of all equipment shall be done away from plantings or any surrounding natural areas will be required where herbicides are used. On this project, it is anticipated that herbicides will be used primarily to control invading woody vegetation. Spot noxious weed management is also anticipated.

E. Herbicides should not be transported into the working area in any container except the container designated as an application tool, or in the manufacturer's original container.

F. Drift should be minimized by not applying herbicide in unsuitable weather conditions according to label directions and by using low pressure spray techniques.

G. Water will be brought to the site by the contractor, or pumped carefully from natural sources.

H. A sufficient supply of chemical absorbent shall be available for spill containment.

I. Any spill will be treated with absorbent and reported to the project ecologist. All clean up shall be according to the best management practices as required by agreed upon by local, state, and federal guidance.

J. Applicator shall have on the premises the appropriate herbicide labels and MSDS (Material Safety Data Sheets) for the chemicals being applied.

3.4 CLEAN-UP, REMOVAL AND REPAIR

A. All debris generated by the work crews (food wrappers, beverage containers, cigarette butts, oil cans, etc.) shall be routinely removed. A routine inspection shall be made by the project ecologist to insure that this is occurring.

3.5 INSPECTION

A. Preliminary Inspection:

1. Upon the complete installation of the landscape work, request a review by the ecologist to determine whether landscape work conforms to the requirements of the contract documents.

B. Preliminary Acceptance:

1. When the ecologist determines that the landscape work conforms to the requirements of the contract documents the landscape contractor will receive a written notification of preliminary acceptance.

2. The maintenance period will commence upon the date specified by the notification of preliminary acceptance. Currently it is anticipated that the maintenance period will begin in 2010.

C. Final Review:

1. At the end of the maintenance period, request a review by the ecologist to determine whether landscape and maintenance work conforms to the requirements of the contract documents.

D. Final Completion:

1. When the ecologist determines that the landscape and maintenance work conforms to the requirements of the contract documents the landscape contractor will receive a written notification of final completion.

2. The Owner will accept maintenance responsibility upon the date specified by the notification of final completion.
3. Continue maintenance of landscape work until the date that the owner accepts maintenance as specified by the written notification of final completion.

END OF SECTION

APPENDIX E.

MONITORING PLAN & PERFORMANCE CRITERIA

ALBANY RAPP ROAD LANDFILL
ECOSYSTEM MITIGATION, RESTORATION & ENHANCEMENT PLAN

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1. INTRODUCTION

The following sections describe the monitoring requirements and performance standards for the wetland restorations and enhancements associated with the eastern expansion of the Albany Rapp Road Landfill. This document also includes a common understanding of the measurement systems that will be used to document restoration program success and trigger points for final acceptance of the restoration areas. Readers are referred to the plan set in **Appendix 1** which contains a **Monitoring Plan Sheet (M.0)** that shows the locations of monitoring transects and other measurement locations proposed throughout this document.

2. MONITORING REQUIREMENTS & PERFORMANCE STANDARDS

Table 1 provides the monitoring requirements, sampling methods, and performance standards for the Rapp Road Landfill Eastern Expansion Mitigation Project. Annual vegetative monitoring will begin prior to construction (baseline 2007), continue in 2010 in conjunction with the landfill expansion into permitted wetlands for an anticipated period of 10 years (beyond the initiation of the final restoration phase), and end at the time of issuance of a Certificate of Completion or another mutually agreed upon time.

The qualitative plant and faunal goals for the wetland mitigation area are listed below:

1. Plants and Birds Response to Restoration and Enhancements

    - There will be a measured increase in richness in plants and birds.
    - There will be an increase in habitat availability to support wider use by native plants and birds after restoration.
    - The trailer park properties once restored will harbor richer plant and bird communities during breeding and migratory seasons than the current trailer park lands.
    - The new habitat areas will provide breeding and migratory season habitat-use opportunities.
    - The restored plant communities will meet the compositional and diversity criteria in the restoration specifications.

2. Herpitile Response to Restoration and Enhancements

    - There will be a measured increase in richness in herpitiles (reptiles and amphibians).
    - There will be an increased habitat availability to support wider use by herpitiles.
    - The new habitat areas will provide breeding and migratory seasonal habitat-use opportunities.

These qualitative goals will be used as the framework for analysis over the 10-year monitoring reporting periods.

2.1 Restoration Milestones

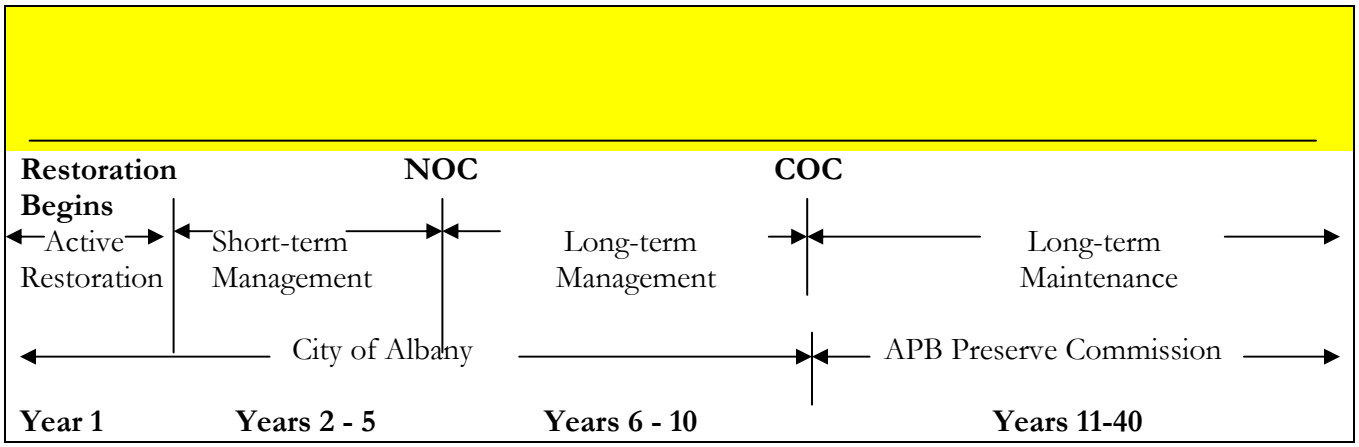
To better understand the timing of the restoration process, it is necessary to differentiate the periods of active restoration, short-term and long-term management, and long-term maintenance (Figure 1). Active restoration includes that time period during which activities such as surface contouring, topsoil placement, initial seeding and live plant installation, and general site stabilization are conducted. Short-term management is considered that period of time following active restoration and the submittal of a

Notice of Completion (NOC) of restoration. The short-term management period requires an intensive level of site management to ensure site stability. Long-term management is considered that period of time between the NOC and the issuance of a Certificate of Completion (COC) or other standard agency documentation. The long-term management period requires a moderate level of site management activity on an annual basis to achieve the following:

- Development of the restored native plant communities consistent with naturally occurring plant communities
- Establishment and support of native volunteer species wherever possible
- Management of all target vegetation types using approved methods

Long-term maintenance is considered that period of time that extends beyond the COC during which time appropriate methods will be used to maintain the targeted restored vegetative conditions. The principal method for long-term maintenance will be prescribed burning, with other methods applied periodically as needed including brush treatments, spot herbicide application, mowing, and other approved activities.

Figure 1. Proposed Management/Maintenance Definition and Timeline



Performance Standards

As part of the wetland mitigation concept, a set of performance criteria has been developed for the property to assess the success of wetland and other plantings. Annual quantitative vegetation monitoring and data analysis to measure performance and determine compliance will be according to the following standards. The performance criteria used for evaluating the subject property are presented in italics below.

HYDROLOGY

Wetland status

Jurisdictional Status: Wetlands created or restored for credit shall meet the criteria for wetlands detailed in the 1987 Corps of Engineers Wetland Delineation Manual, or other such Federal manual used by the Corps at the time the mitigation bank was established.

The 1987 US Army Corps Wetland Delineation Manual indicates that an area exhibits wetland hydrology if it is inundated or saturated within 12 inches of the surface on consecutive days for at least 12.5% of the growing season (Primary Hydrology Indicator). If an area is inundated or saturated for between 5% and 12.5% of the growing season the area must meet at least one primary hydrology indicator and/or two secondary hydrology indicators to exhibit wetland hydrology. Areas inundated or saturated for less than 5% do not exhibit wetland hydrology and therefore, are not wetlands.

According to the local NRCS Office, the average growing season in Albany County is 147 days (May 15th – October 25). If inundation or saturation is within 12 inches of the surface for a minimum 19 consecutive days in Albany County the primary hydrology criteria has been achieved. If not, additional data will be analyzed and the use of additional primary and secondary hydrology criteria will be evaluated.

Telogs will be used as the primary means to measure inundation and saturation (Primary Hydrology Indicator). In addition to Telogs, soil moisture recorders, and a soil moisture probe will also used to measure for soil saturation.

Sixteen automatic water level recorders (i.e. Telogs) and 6 soil moisture level recorders will be installed at the site in areas designed to be wetlands to measure the water levels above and below ground and the soil moisture. The automatic water level recorder will provide a constant record of water level through electronic measurements via a pressure sensitive transducer.

Soil Moisture Recorders

The soil moisture recorders provide an electronic measurement of the level of moisture in the soil. The data will be downloaded from the automatic water level recorders and soil moisture recorders and graphically displayed. The soil moisture recorder measures the dielectric constant of soil in order to determine its volumetric water content. Six soil moisture recorders will be installed on the site. There will be two different probe depths in each unit. One will record data at 6 inches below the ground's surface and the second will record data at 12 inches below the surface. During operation, values of 0.0 to 0.4 m^3/m^3 are possible. A value of 0.0 to 0.1 m^3/m^3 indicates oven dry to dry soil, respectively. A value of 0.3 to 0.4 m^3/m^3 indicates wet to saturated soil. Thus, any value of 0.3 or greater will be indicative of a saturated soil. These soil saturation levels, which will promote the growth of a predominance of hydrophytic vegetation, will have a value 0f 0.3 or greater within 12" of the ground surface for a minimum of 19 consecutive days in Albany County.

Soil Moisture Meter Probe

A Soil Moisture probe will also be used along several transects to measure the soil moisture content within 12 inches of the soil surface in areas between the Telogs and soil moisture meters. Several transects will start in an existing wetland and will extend upslope to an upland zone. Following calibration of the moisture meter in 100% saturated soils; the probe will record soil moisture values every 20 meters along each transects to a depth of 12 inches. Each point will be surveyed using a hand-held GPS unit. A soil moisture meter probe value of 0 represents Dry (0% saturation) soil; values of 2-4 represent Average to Dry soil; values of 4-6 represent Average soil moisture, and values greater than 7 generally represent saturated soils. Data collected will be summarized and provide supporting data for achievement of the hydrology performance standard.

Primary and Secondary Hydrology Indicators

The Corps 1987 Wetland Delineation manual states a site must exhibit one or more "Primary Hydrology Indicators" and/or two or more "Secondary Hydrology Indicators" to meet wetland hydrology requirement.

Primary and secondary hydrology indicators such as drainage patterns, soil survey data, and hydrophytic vegetation dominance (Fac-Neutral Test) will also be evaluated for achievement of the hydrology performance standard.

Local Hydric Soil Map.

The historic Albany County Soil Survey maps showed nearly all lower ground soils in the Trailer park to have been former hydric soils that have been filled with the sand mining and subsequent land leveling created to support the existing trailer park. These soil types are somewhat poorly drained and hydric soils in the County. These soil types were confirmed during site visits. The presence of mapped hydric soils is another secondary indicator of hydrology.

A wetland delineation with a GPS boundary survey of wetlands and natural community mapping will be conducted in the spring, beginning in year 2 and be conducted again in years 3, 4, 6, 8, and 10 of the ten monitoring period that is tentatively scheduled to begin in 2010 (Table 2).

VEGETATION

Species Composition

Species selected for the planting shall be native to the county where the mitigation site is located and shall be appropriate for the hydrologic zone to be planted. A minimum number of native perennial species proposed for establishment must be present within each plant community to meet performance standards are as follows:

-Pine barrens vernal pond minimum of 12 native perennial species
-Sedge meadow/wet prairie minimum of 20 native perennial species
-Dry prairie (buffer) minimum of 20 native perennial species
-Forested wetland minimum of 12 native perennial species

In addition, at least 50% of the required minimum number of species must occur at a 10% frequency or greater by year 5.

Species Dominance

Dominance shall be determined by calculating importance values (IV), with at least two parameters, frequency and cover, used to calculate species importance. Cattails (*Typha* spp), reed canary grass (*Phalaris arundinacea*), and non-native species shall cumulatively comprise not more than 20% of the total dominance measure for each community for which credit is granted. The native perennial species within each wetland plant community shall represent at least 70% of the total dominance measure.

3. THE MONITORING PROGRAM

Typifying or representative areas from the major restoration zones will be monitored using the following program.

The following quantitative ecological methods (please see Table 1 and Bibliography for

technical literature citations) have been selected to address each of the aforementioned monitoring performance standards:

Percent cover

- Line transects and nested 1 square meter sample quadrats
- Permanent transects comparison with annually randomized transects

Diversity

- Line transects and nested 1 square meter sample quadrats
- Comparison between permanent and annually randomized transects
- Timed meander search
- Nested belt transects-cover intercept and diameter breast height
- Point-plot avian census technique
- Derived measures
- Frequency of occurrence
- Importance value
- Richness
- Habitat rating

4. MEASUREMENT METHODS AND TECHNIQUES

This section provides a description of each method proposed to measure the restoration outcomes for the Property. Table 1 identifies each monitoring requirement, the methods of measurement to meet performance standards, sampling sufficiency determinations, and the technical literature citations pertinent to the methods of sampling and data analyses and interpretations for each monitoring requirement.

4.1 Line Transects and Nested 1 Square Meter Sample Quadrats

An approximate location map of Transects, water monitoring wells, bird study stations, and water quality and stream gage Stations for collection of the annual monitoring data as part of the 10 years of ecological monitoring beginning in 2010 (Table 2) is found in found in Figure 1 of this attachment. Transect direction will be established with randomly generated compass bearings. Starting from each randomly chosen grid point, a 100-meter measuring tape will be pulled taut along the randomly chosen compass bearing. The transect end points will be GPS surveyed and permanently marked with ground flush steel rebar rod.

Sample quadrats will be placed at 10-meter increments along each transect. At 10-meter increments along the measuring tape, a circular meter square quadrat will be centered over the tape and the herbaceous plant percent cover (a measure of the vertical projection of photosynthetic leaf area) will be measured in each quadrat:

The recorded data at each quadrat will include:

- Percent cover by species including all woody plants of less than 1.0-meter height
- Percent cover by substrate type (fine litter, 1 hour combustible fuels), coarse litter (>1 hour combustible fuels), rock, bare soil, and bryophytes (mosses, lichens, liverworts, etc.)

The following information and results will be derived from the data collected from each quadrat:

- Frequency of occurrence (percent of the total number of sample quadrats in which each species occurs)
  Richness (number of plant species)
- Erosion control effectiveness (average +- St. Deviation for percent bare soil and percent total plant and substrate cover/quadrat)
- Absolute and relative cover
- Frequency of occurrence
- Importance Value (IV), the summation of relative cover and frequency of occurrence for a given species
  IV, percent cover, and frequency of occurrence data will be calculated for each plant species for each transect, community type, and overall site performance level

In addition, a timed meander search, described below, will be used to help develop plant species richness and plant diversity in the wetlands and upland plant communities.

4.2 Timed Meander Search Technique

Plant species richness and diversity in each community type will be sampled using the Timed Meander Search (TMS) technique[5]. The TMS technique involves slowly walking though each plant community type and listing new plant species while blocking the search into increments of time. The TMS sampling technique will cover representative areas of the site. The TMS method develops time-equated plant species lists. The data contribute to the development of total plant species lists and help quantify diversity for each plant community. The data contribute not only to the species lists and diversity measurements, but statistics can be used to help characterize community development and compare different areas within the same community type.

4.3 Nested Belt Transects-Cover Intercept and DBH

Woody vegetation equal to or greater than 1.0-meter height will be sampled along the identical 50-meter linear study transects laid out for percent cover as described above. Parallel belts, two meters wide and nested within the 100-meter transects, will be laid out on both sides of a study transect. The woody plants ≥ 1.0-meter encountered within each 4-meter wide x 100-meter linear belt transect will be measured for:

- Percent canopy intercept (vertical projection of photosynthetic leaf area, over measured lineal distance of transect tape)
- Survivorship (measured as alive or dead canopy intercept)
- Diameter and if appropriate, Diameter at Breast Height [DBH- 4.5 feet above ground]
- Number of stems for each woody plant species

4.4 Permanent Transects Comparison With Annually Randomized Transects In Representative Community Types

Along with the permanent transects used to measure vegetation (e.g. annual use of identical quadrat and belt transect locations), a number of different randomized transects will be installed each year. An appropriate number of the additional random transects will be determined statistically. These random

transects will be sampled in the same way as the permanent transects. Data will be summarized, analyzed and compared statistically with the analysis from the permanent transects. The statistical comparison will evaluate whether the paired samples are from significantly similar populations, and if so, confirm the assumption of random sampling, which strengthens statistical robustness.

5. FAUNAL SURVEYS

5.1 Bird Surveys

Above and beyond the proposed wildlife habitat evaluation procedure, City of Albany intends to document and characterize breeding bird use of the habitats created through surface restoration activities. Therefore, breeding birds will be sampled as a measure of wildlife habitat quality. Bird surveys were conducted during the baseline year (2007) and will be surveyed again in Years 1, 2, 3, 4, 5, 6, 8, and 10 (Table 2). Richness (number of species of birds), breeding bird density (number of breeding pairs by species) and spatial and habitat-use affinities (mapped locations of bird use relative to habitat types) are the avian variables that will be measured. Sampling will be conducted during the period late May through late June during the breeding season. An additional sampling for bird species will occur in spring and fall for detecting migratory bird species. Sampling points will be spatially correlated or may coincide with transect end points and habitat types.

Representative study locations will be chosen throughout the Property after an initial reconnaissance of the property. Locations to be studied on the site will be identified once a fundamental understanding of the complexity, patchiness, and types of avian habitat present on the landfill site has been ascertained. Study points must be spaced sufficiently throughout the site to ensure independence of data from other study points. A preliminary location of potential bird sampling areas is shown in the monitoring point location map in Figure 1 of this attachment.

Avian surveys will use modified methods[15] designed for quantification of richness and relative abundance of bird species. At each study point birds will be surveyed daily at dawn through mid-morning over four consecutive days during summer breeding under suitable meteorological conditions. Arrival at each study point will be followed by one-to-two minutes of acclimation while data sheets are being labeled as to time, date, surveyor, study point number, and survey identification. During timed surveys (using stopwatch) the bird species heard or observed each minute will be recorded and locations mapped. Surveys will be continued until no additional species are recorded at each study point, often requiring 15-20 minutes of total survey time. Only after at least four consecutive minutes with no new-recorded species are surveys complete at each point and the survey is terminated. The modification of the Reynolds et al. (Ibid.) method is similar to the Goff's proposal for surveying plants. Additional listings of birds observed or heard in the property but not at study points will be noted while moving between study points. Identification and nomenclature for birds follows Robbins[16] and the American Ornithological Union[2].
All raw field data will be entered into a database to create a list of birds as well as for summary and analysis. This study will determine the breeding status of species identified during surveys. Avian breeding status on the site will follow the criteria adopted by the Illinois Department of Conservation (IDOC) for the Breeding Bird Atlas Project[7] or other appropriate criteria. These criteria will be used to document the status and distribution of breeding birds and are adopted for use in this study. Criteria are:

1). Observed: A species, male or female, was observed during the breeding season, but no evidence exists to indicate the species is breeding.

2). Possible: A species, male or female, was observed in suitable habitat and at a time during the breeding season that indicated it was possible that breeding occurred. Singing males often indicate possible breeding.

3). Probable: Several types of observations are available that would indicate the species is probably breeding. Multiple males singing in suitable habitat, a pair (male and female) observed in suitable habitat, a permanent territory is identified by multiple observations of a singing male or male/male conflicts, courtship or copulation is observed, or agitated behavior.

4). Confirmed: This is the most important level of classification. Observation in this category indicates direct evidence that the species is breeding at the site. Nest building by species other than wrens or woodpeckers, physiological breeding evidence, distraction displays, a used nest or eggshells, recently fledged young, an occupied nest, adults carrying a fecal sac or food, a nest with eggs, or a nest with young seen or heard.

5.2 Fish Surveys

Fish sampling using seining techniques with a 6-15 mm seine net mesh diagonal size by 10-15 meter long and 2 meter deep net will be used every 2 years in wetland P4 during the period that the restoration plan is under construction. The goal of this sampling is to verify the absence of especially predaceous fish species that may present a threat to use of the wetland by some amphibians and other biota. A brief memorandum of findings shall be provided within 90 days of sampling to document findings. In the event that predaceous fish are found, a remedial action plan to again treat the wetland to eliminate the fish will be prepared and submitted for the management team review and considerations in advance of any fish removal treatments. In addition to the above mentioned techniques for the sampling of the presence or lack thereof of predaceous fish, minnow traps will be installed in wetland P4 to assess the presence of minnows. 10 traps will be inserted twice a year for a 2 week period in the spring and fall for the duration of the project.

5.3 Lepidoptera Surveys

The section of the monitoring plan includes the monitoring methods for Karner Blue Butterfly, Frosted Elfin, and for determining habitat suitability for these threatened and endangered species. Monitoring protocols for the inland barrens buck moth, a diurnal Special Concern species are also described. Nocturnal Special Concern moths will be sampled with standard nocturnal black-lighting methods, timed for their spring and summer emergence periods per mutual agreement with Pine Bush Staff. We acknowledge in this method that a likely requirement of any TRP issued for restoration on Preserve lands may include diurnal butterfly and nocturnal moth sampling and we propose to include more detailed methods for the other species in association with the annual work plans.

Survey Protocols

Some butterfly's have a single and the Karner blue butterfly has two broods and flight periods per year; the first flight normally begins in mid- to late May and ends in mid- to late June and the second flight normally begins in mid-July and ends in mid-August. However, the timing of the flight periods for Karner and other butterfly species can vary by as much as 2-3 weeks from year to year and/or site to site due to weather and microclimatic influences. The length of the flight periods may also vary from year to year (generally 2-5 weeks). Since it cannot be known when the flight periods commence until field observers begin to report sightings of the butterflies, discussions with the Service/State are necessary prior to conducting surveys for either species to refine the survey window for any particular

year. Surveys shall be conducted by an individual knowledgeable in identification of the butterflies (see descriptions and photographs in the Recovery Plan for the Karner blue butterfly attached below). Identification photographs of butterflies can also be obtained from the State/Service. Please note that scientific collector permits are required by the State for butterfly surveys. Please allow for adequate processing time to ensure that permits are in place prior to the first flight period.

Determining Butterfly Presence and Abundance: Intensive Search Method

- Survey all potential habitat areas for the butterflies. This includes all lupine patches as well as nectar and grassy areas that may provide adult food and/or shelter for butterflies.

    - All of the lupine, nectar, and nearby grass habitat should be carefully searched by slowly walking over it, gently prodding vegetation with butterfly net or meter stick, and/or stopping frequently and scanning the area for movement. The search should criss-cross all of the potential habitat area until the surveyor can be confident that all potential habitats have been searched. If more than five individuals are found, a zigzag transect may be done in later surveys to establish butterfly abundance (see Zigzag Transect Methods below). However, if the zigzag method is subsequently employed and such surveys do not pick up butterflies regularly, the intensive search should be conducted to continue to confirm presence.

- To determine butterfly presence, conduct a minimum of 5 surveys per Karner blue butterfly flight period with a total of 10 surveys needed to establish baseline conditions for the Karner blue butterfly (weather permitting) (call the State to confirm the start and finish of flight periods at nearby locations). At least 2 of the surveys should be conducted during mid- to late May to overlap with the frosted elfin flight period.

- Visits should be spaced so that no more than 2 days pass between visits unless weather is unsuitable. This reduces the potential for missing peak butterfly abundance in each brood. If poor weather is predicted, consider making visits the day before if waiting until after the bad weather will cause more than 3 days to pass between visits. If bad weather is expected part of a monitoring day, try to survey that day by adjusting the monitoring schedule accordingly.

- We recommend conducting all 10 surveys, even if butterfly presence is documented during an earlier survey, to document the use of nectar areas and get the best possible peak count of butterflies within each flight period. This will assist the Service/State with determining an initial index count of butterflies within the site, which can be monitored over time to determine the effects of the proposed management actions.

- Conduct surveys during optimal time and weather conditions as listed below:
    - Between 8:00 a.m. and 6:00 p.m.
    - When temperatures are above 65°F
    - When temperatures are between 65-70°F, surveys should only be conducted under mostly sunny skies with calm to light wind
    - When temperatures are above 70°F, no restrictions on cloud cover
    - When eye-level winds are less than 20 mph

- Additional weather notes:

- do not survey under drizzly or rainy conditions, however surveys can continue through very light rain if the sun is shining and the temperature is 75°F or higher.
- Delay surveying after heavy rain until the vegetation and the butterflies have had a chance to dry

- Time Keeping:
  - Record the duration of each survey. For sites with more than one transect, record duration of each transect and provide a total time (and total butterflies) as a separate data sheet entry. Duration must be recorded to the second. Do not round off minutes! Record time of day in military time. Record the time of day you visit the site even if you use a stop watch to time the duration. If you are not using a stopwatch, record your start time and end times in military time and include the second (*e.g.*, 1417:00 - 1418:23). It helps to start at 00 seconds or 30 seconds to make it easier to subtract out later. Include duration of search even for zigzag and exhaustive searches.

Determining Butterfly Presence and Abundance: Zigzag Transects Method

Establishing Transects

- As reported in McCabe (1993), zigzag transects should be designed to cover each site. Transects should remain constant from day to day and for both broods. If monitoring longer term, transects should also remain constant from year to year so that data can be accurately compared through time. If the transect needs to be expanded (i.e., due to expansion of lupine population), it should be segmented so that data collected from the original transect can continue to be compared to that of previous years.
- The distance between zigzags shall be sufficient to avoid counting an individual butterfly more than once. The distance between zigzags can be increased in areas where high butterfly densities would have resulted in many butterflies being counted more than once.

• Standard Methods

- Observers walk at a comfortable pace gently swinging a butterfly net above the vegetation to stir the butterflies into motion. All butterflies seen, both at rest and in flight are counted and their numbers recorded on a data sheet. Butterflies that fly into areas not yet walked are to be counted only if they fly no further than one zigzag ahead. Butterflies which fly farther than one zigzag ahead are left to be counted later in the walk-through (McCabe 1993). Butterflies that fly out of the census area are counted.
- The sex of a butterfly should be recorded during the walk if it is obvious to the observer (*i.e.*, a butterfly sitting in the path of the observer with its wings open). However, sexing butterflies during the transect walk should be done judiciously so as not to change the length of time necessary to walk the site or introduce inaccuracies caused by losing track of counted butterflies. A separate walk-through should be conducted in order to determine the sex ratio of the butterflies.
- After completing the transect walk and sex ratio determination, Karner blue butterfly nectar species should be noted and the number of butterflies observed to be nectaring recorded. Other plants in bloom and weather notes should also be recorded on the data sheet.
- Follow weather and time protocols listed above.
- Marked transects may be along a continuous line or in zigzags, as long as they cover the entire potential habitat on a site.
- Keep eyes forward a short distance ahead but regularly glance toward your feet and about 10 feet ahead. This will help you to stay on the transect and avoid trampling too much lupine. Also sometimes the butterflies won't fly up as you step over them.

- Keep walking at a steady pace, about one heart beat per step. Avoid the tendency to slow down as you get into a lot of butterflies and speed up when there isn't much lupine. If you wander off the transect route by more than a few feet, start over again. Do not try to slow down or speed up to keep your time exactly the same, but practice your pace to try to keep it steady enough that you are doing the transect within 10-15 seconds of the same duration each time.

- **NOTE:** CENSUS NUMBERS SHOULD NOT BE INTERPRETED AS THE ABSOLUTE NUMBER OF KARNER BLUE BUTTERFLIES IN A GIVEN SUB-POPULATION. RATHER THEY REPRESENT AN INDEX FOR THE SIZE OF AN INDIVIDUAL SUB-POPULATION THAT CAN BE COMPARED FROM YEAR TO YEAR. ONLY IN INSTANCES WHERE THE SUB-POPULATION IS QUITE SMALL AND CONFINED TO A WELL-DEFINED AREA THAT CAN BE CENSUSED THOROUGHLY DO CENSUS NUMBERS APPROACH THE ABSOLUTE NUMBER OF KARNER BLUES IN A GIVEN SUB-POPULATION AT A GIVEN DAY.

• Zigzag surveys (for sites too small to effectively monitor with marked transects)
  - Monitors should strive to walk the same areas each time, but essentially should cover the entire habitat without counting butterflies twice. The zigzag surveys for unmarked transects should be done as described above for marked transects.

5.4 Reptile and Amphibian (Herpitile) Surveys

No Baseline reptile and amphibians studies have been conducted but we propose to use similar techniques to develop sampling protocol are used to identify and evaluate herpetological communities in the Wetland Mitigation site (Table 2).

Beginning in year 1 of the 10 year monitoring program, a site reconnaissance will be conducted to relocate the previous sampling stations if possible. Depending on the habitat type, sampling stations will be defined by transects or by individual habitat features (e.g., pond or stream shorelines), or by random searches through a distinct habitat type. Sampling stations associated with stream channels and pond areas will be established by walking the edges and shallow portions of the water bodies for a known distance.

Several survey techniques will be employed in order to effectively sample a wide variety of habitats and attempt to encounter as many species as possible. The primary method to be used will be visual encounter surveys. Visual encounter surveys are timed, systematic visual searches of suitable habitat. Shoreline and other appropriate habitats will be walked slowly and visually searched for herps. In addition, any frogs or toads heard calling in the immediate vicinity of a sampling station also will be noted during visual encounter surveys. Visual encounter surveys will be conducted during both daytime and nighttime in order to maximize the likelihood of detecting nocturnal species.

Dip netting, seining, cover turning, and aquatic funnel traps will be used as appropriate to complement visual encounter surveys. These additional sampling approaches will be employed to maximize the possibility of detecting species that generally remain hidden in vegetation, underneath cover, or in other areas where they may go undetected during visual searches.

Cover turning is the lifting and turning of cover objects, such as rocks, logs, boards, and other large objects under which animals can find shelter. Cover objects encountered at a sampling station will be turned and then returned to their original position after being searched. Aquatic funnel traps, consisting of standard minnow traps, will be used to sample amphibian larvae and adults in pond and stream habitats.

All collected or encountered herps will be identified to species and counted. Numbers of organisms occurring in large aggregations, such as tadpoles or calling frogs will be estimated, with representative individuals being collected for identification. All collected herps will be released unharmed in the vicinity of their point of capture following identification and enumeration, with the exception of a few representative specimens of tadpoles, which may have to be retained.

5.5 Hydrology Monitoring

The hydrologic monitoring conducted will include wells (Telogs), continuous soil moisture recorders, hand held manual soil moisture meter probes, and the observation of primary and secondary hydrologic characteristics (the prevalence of vegetation which is adapted for anaerobic soil conditions and other secondary characteristics) to determine hydrology for the site.

Telog
The Telog monitoring wells will consist of a single PVC pipe protected by a steel shaft. The 2' diameter x 48" PVC well is fitted with a Telog unit consisting of an electronic data logger with a pressure sensitive transducer to provide constant water level monitoring. Sixteen Telog recorders will be installed. Each Telog will be downloaded monthly from April-October.

The criteria for establishing if wetland hydrology is being achieved for Telog data is to determine the maximum number of consecutive growing season days the water in the wells is within 12" of the ground surface. The 1987 Corps Manual indicates that a predominance of vegetation which is indicators of hydrology should grow when the water level (100% soil saturation) is within 12" of the ground surface between 5% and 12.5% of the growing season. The average growing season in Albany County runs from May 1—Oct 20. The actual growing season in wetland areas is slightly longer and begins on approximately April 15 resulting in a 189-day growing season. The water levels which will promote the growth of a predominance of hydrophytic vegetation should be within 12" of the ground a minimum of 10 days to two weeks in Albany County.

Soil Moisture Recorders
The soil moisture recorder measures the dielectric constant of soil in order to determine its volumetric water content. Six soil moisture recorders will be installed on the site. There will be two different probe depths in each unit. One will record data at 6 inches below the ground's surface and the second will record data at 12 inches below the surface. During operation, values of 0 to 0.4 m^3/m^3 are possible. A value of 0.0 to 0.1 m^3/m^3 indicates oven dry to dry soil, respectively. A value of 0.3 to 0.4 m^3/m^3 normally indicates wet to saturated soil. Thus, any value of 0.3 or greater will be indicative of a saturated soil. These soil saturation levels, which will promote the growth of a predominance of hydrophytic vegetation, will have a value 0f 0.3 or greater within 12" of the ground surface for a minimum of 19 consecutive days in Albany County.

Soil Moisture Probe
The Soil Moisture Probe consists of a hand held unit with a moisture sensor that is calibrated on site by placing the sensor into soil that is known to be 100% saturated and calibrating the probe to 100%. Several transects will be established that both begin in the existing wetland and extend upslope to an upland area. The unit will be driven into soils every 20 meters to a depth of 12 inches. The unit has meter reading categories related to the amount of moisture in the ground at the level of the sensor. A reading of 0 equals Dry (0% saturation); 2-4 equals Average Dry; 4-6 equals Average, 6-8 equals Average Wet; and 10 equals Wet (100% saturation). The criteria for establishing the hydrology criteria via the Soil

Moisture probe is when the meter reads between 7 and 10+ within 12" of the surface a minimum of 19 days (12.5% of growing season) throughout the growing season.

Primary and Secondary Hydrology Indicators
According to the Corp 1987 Wetland Delineation Manual, a site must exhibit one or more "Primary Hydrology Indicators: and/or two or more "Secondary Hydrology Indicators" to meet wetland hydrology requirements. The hydrology on a site determines the type of plants that grow and the soils that develop. When hydrology is present, hydrophytic plants dominate. The Corp 1987 manual states that the hydrophytic vegetation criteria for wetland classification is met when greater than 50% of the dominant plant species are hydrophytes. The indicator status of plant species is expressed in terms of the estimated probabilities of that species occurring in wetland conditions within a given region. Hydrophytes include all plants classified as "FAC" (with the exception of "FAC-"), "FACW" or "OBL". According to the 1987 manual, a dominance of hydrophytes is also a secondary indicator of hydrology (Fac neutral test). Vegetation data will be collected throughout areas designed as wetlands and the percentage of plants having wetland status determined.

When wetland hydrology is present for given periods of time, hydric soils begin to form. County soil survey maps include the location of hydric soil units that can be used to determine if hydric soils are present on a site even if previously existing wetlands are no longer present. In addition in field soil sampling to determine the soils chroma will be evaluated. Soils with a chroma value of 1 or less meet the wetland soils criteria. In addition soils with a chroma value of 2 and have mottling also meet the wetland soils criteria. The presence of a hydric soil and the presence of mapped hydric soil is also a secondary indicator of wetland hydrology.

6. SCHEDULES FOR IMPLEMENTATION

6.1 Construction Phase On-site Monitoring

CITY OF ALBANY is committed to the highest quality of workmanship and creating a successful mitigation program outcome. On-site third party monitoring and oversight personnel with commensurate qualifications and appropriate wetland restoration experience will be involved in oversight of layout, final grading and other critical construction activities in the mitigation project areas on an as-needed basis. The on-site monitor will provide appropriate documentation of accomplishments to CITY OF ALBANY, photo-document construction activities and be available for discussion and updates during the construction phase with the agencies. CITY OF ALBANY anticipates that a full time availability commitment will be required by the onsite monitor during the critical construction phases of the Wetland Mitigation Project for compliance with permit conditions and approved agency(ies) plans.

Implementation schedules are projected for all monitoring tasks and years for the restored wetlands in Table 2. This table identifies the likely quarter of each year when each of the tasks and performance measures will be implemented. There are two primary sampling periods for vegetation: Early summer and mid-to-late summer. Timed Meander Search (TMS) will occur in both early summer and mid-to-late summer. Quadrat analysis will occur in mid-to-late summer. A single breeding avian sampling period will occur in late May-to-late June, concurrent with the early season TMS and migratory bird surveys will also occur in early spring and Fall in years scheduled in Table 2. Herpitile and fish surveys will be conducted spring of scheduled years (Table 2).

7. DATA ANALYSIS AND STATISTICS

Plant data usefulness is directly related to the statistical design and quality of the data collected. Sampling strategies, plot design and layout, and data collection methods proposed in this report ensure that assumptions of statistical analysis to be employed are understood and integrated. The strategies and methods follow standard procedures as detailed in Greig- Smith[6], Sokal and Rohlf[19], and Zar[26].

- For all sample plots, standardized, and reproducible primary and secondary methods of data summary and analysis will be employed
- Plots will be laid out to provide measures of trend analysis (repeated sampling strategies) or plots will be partitioned or split to establish separate controlled replicated opportunities which provides for the use of the most robust non-parametric statistics and the use of standard statistical software for analysis such as SPSS, SAS, Systat, etc.
- Multivariate statistical analyses (cluster analysis, ordination, etc.) provide powerful methods for illustrating relationships among data and variables
- Automatic water level data will be periodically downloaded and graphically displayed in annual monitoring reports

Sampling of the variables in each community type and use of sampling sufficiency analysis during the field work will be used to determine the number of transects required to meet 90% confidence limits for the key variables measured. All plant identifications will follow Gleason[4] as the taxonomic authority for this monitoring program.

8. REPORTING

8.1 Baseline Condition Documentation

CITY OF ALBANY will continue developing baseline documentation of biological resources in restoration and mitigation areas and use these baseline condition measurements for tracking and future comparison of biological performance in annual reporting of mitigation success. CITY OF ALBANY will conduct baseline ecological monitoring for the Wetland Mitigation Project as described in Table 1 and at a frequency outlined in Table 2 prior to the commencement of construction activities required to provide the required hydrological zones in the Wetland Mitigation Project. Ecological monitoring will not occur during the construction period, but will begin after a record topographic map is submitted. Hydrological monitoring equipment will be installed after site construction and then the seeding plan will be submitted and planting will begin. This will constitute year 1 as shown in the attached Table 2 and continue for a total of ten years.

8.2 Contingency Planning for Poor or Biological Non-performance of the Mitigation Project

CITY OF ALBANY will prepare contingency plans for areas of the Wetland Mitigation Project site that are in substantial non-compliance with the performance criteria established for each vegetation restoration zone. Substantial non-compliance is defined to occur when the measured performance of the monitored vegetation variables for which quantitative performance criteria have been established (see attached Table 1) are not being met or anticipated to be met on the timeline in the plan. Contingency plans will provide the process to resolve poor and non-performance issues and locations. Plans will be delivered to CITY OF ALBANY by its consultant/contractor after the annual monitoring

reports are reviewed where the poor and non-performance is an acknowledged trend decisively shown in the monitoring data. CITY OF ALBANY will deliver the contingency plan to NYDEC and USACOE to inform agencies on the intended direction to reconcile the biological non-performance. Commensurate monitoring and reporting will be provided by the CITY OF ALBANY to document resolution of biological non-performance.

8.3 Milestones and Performance Requirements for the Mitigation Project

The initiation of the mitigation restoration timeline is triggered with the generation of a record topographic survey of restoration phase areas. The hydrological milestone accomplishment (Section 2.2 Hydrology) is anticipated to be provided (by CITY OF ALBANY) to NYDEC and USACOE no later than the end of year 2 of the ecological monitoring period. Acceptance of hydrological performance sooner than two years may be allowed at the NYSDEC's and USACE's discretion to allow for flexibility and will be exhibited in any linked decisions found elsewhere in the permit.

Other performance milestones are outlined in attached Table 1. A series of floral, faunal, and hydrological parameters will be monitored (Table 2) by the CITY OF ALBANY restoration team and when milestones are achieved, CITY OF ALBANY will notify NYDEC and USACOE and request a field visit and appropriate responses including annual concurrence on achieved milestones, and ultimate notice and certificate of completion.

Annual restoration monitoring reports will be provided no later than December 31st each year, unless an extension date is requested in writing to the regulatory agency(ies).

8.4 Schedule and Variables for Monitoring and Reporting

CITY OF ALBANY proposes to monitor the biological and hydrological parameters and report and annual findings in the Wetland Mitigation Project following the schedule in Table 2. The target timeline for proposed agency approvals and signoff are also included in this table.

8.5 Integrated Pest Management Plan for Restoration and Mitigation Lands

CITY OF ALBANY will provide an integrated pest management plan to address exotic species issues, both existing and unforeseen, after the first year of restoration implementation.

8.6 Adaptive Management

The CITY OF ALBANY application is focused on following an adaptive management process throughout the life of the restoration program. CITY OF ALBANY will provide documentation on adaptive management needs of this program in the annual reporting to NYDEC and USACOE. Adaptive management is defined as the day to day, season to season refinements in restoration programming needed for CITY OF ALBANY to achieve success against the performance criteria. This adaptive refinement is not considered critical, and does not require a contingency plan, as this refinement is an anticipated normal process on restoration and mitigation projects. Adaptive management is intended to take advantage annually, and from time to time, of the latest scientific and technological techniques for successfully accomplishing restoration and mitigation projects. This is a regular and routine process that CITY OF ALBANY will follow.

CITY OF ALBANY is fully responsible for the performance of the Wetland Mitigation Project

wetlands during the life of this project. CITY OF ALBANY assumes full responsibility for following the adaptive management protocols and documenting the process used and proposed.

8.7 Notice of Completion and Certificate of Completion

CITY OF ALBANY intends to successfully complete all restoration and provide supporting documentation including annual restoration reports in favor of the submittal of a Notice of Completion (NOC) to NYDEC. Certificate of Completion (COC) request is projected to be at the end of the tenth year, assuming that the substantial completion of the plant installation is designated as year 1 (2010).

8.8 Annual Restoration Report Content

The following report outline highlights the primary elements that the monitoring information and data analysis will focus upon.

8.9 Guild Tracking and Reporting

CITY OF ALBANY will document in the annual monitoring report the trends of guilds of faunal groups and plants. For example, bird guilds are defined as species that have similar foraging behaviors and needs, such as birds that drill on wood for insects (called timber drillers), and birds that forage on the ground (called ground brush foragers). For plants, we propose that two major guilds be distinguished (native and non-native). As wetland restoration is an important component of the mitigation plan these two main plant sub-groups will also be designated as to the likelihood of occurring in wetlands or upland communities. The National List of Vascular Plant Species that Occur in Wetlands (USFWS 1996) will be used to designate plants as either upland (UPL), facultative upland (FACU), facultative (FAC), facultative wet (FACW) or obligate (OBL). For herpitile and fish guilds will be developed in consultation with NYDEC and USACE following completion of the first year of biological baseline data collection. As with the bird and plant guilds, the amphibian and fish guilds will be used in reporting annual results on biological performance in the wetland mitigation and enhancement areas.

The performance standards to be used for fish and herpitiles during the restoration monitoring phase of the site include successfully completing the surveys per the methods, schedule and sampling design layout, and generating the richness and location data for amphibians, and richness and physical habitat conditions for future comparisons to the 2007 baseline conditions being surveyed at the wetland mitigation site.

For faunal groups, the performance standards will be to ensure that the monitoring work and reporting is completed successfully. As a part of this performance requirement, the annual reports will provide an analysis of trends by species, by guild and by community, using richness, frequency of occurrence, and habitat-use mapping, depending on the group.

I. Documentation and Reporting

Documentation Goals:

A. Erosion control effectiveness.
B. Plant community development and trajectory.
C. Habitat development and trajectory.
D. Key wildlife group use and trajectory.

E. Statistical summary of re-vegetation success as compared to permit performance standards.
   - Achievement of vegetation and hydrology milestones.

II. Reporting Frequency

A. Annually, by December 31st, the annual restoration report, and
B. Concludes upon issuance of the Certificate of Completion.
C. Monthly, hydrological reports beginning in May during construction years 1 and 2, as to the properties wetland areas achievement of the hydrology performance standards.

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Table 1. Proposed Ecological Monitoring, Performance Standards, Sampling Methods, and Sampling Sufficiency Determinations for the Rapp Road Landfill Eastern Expansion, City of Albany, New York.

Monitoring Requirement	Performance Standard	Sampling Method	References[1]	Sampling Sufficiency Determination
Percent cover	• 70% at 90% Confidence Interval • Total cover • Measured annually in August or September • Correlated with Aerial Photography • 200+ $1m^2$ quadrats • Sampled throughout, wetland, grassland and woodland communities	• Line transect nested $1m^2$ quadrats • Compare permanent and annual random transects	4, 6	Standard error of means
Diversity	• Frequency of occurrence by species • Minimum 15 species per grassland, wetland and woodland, minimum of 12 species in forested wetland enhancement	• Line transect nested $1m^2$ quadrats • Compare permanent and annual random transects • TMS • Nested belt transects-cover intercept and DBH	4,5,13,14,17,21,22,23,27	
Birds	• Richness • Breeding density • Spatial habitat location	• Point plot • Flush plot • Mapping	1, 2, 3, 7,8,9,10,15,16,17,18,24,25	
Fishes	• Presence/ Absence	• Visual observation (habitat) • Backpack electroshocking • Seining/ Minnow traps	**	
Herpitiles (Amphibians & Reptiles)	• Richness • Habitat location	• Visual encounter survey • Sampling station • Night survey • Ripnet • Seining • Funnel Traps	*	

Monitoring Requirement	Performance Standard	Sampling Method	References[1]	Sampling Sufficiency Determination
Lepidoptera	• Presence/ Absence • Relative abundance • Species diversity • Habitat suitability	• Visual encounter survey • Sampling station • Night survey • Habitat suitability using PB/ DEC/ USFWS methods	See Karner Blue Recovery Plan	
Hydrology	• USACE hydrology criteria • ECL Article 24	• Telogs		Standard error of means and repeatability

[1] See Bibliography

Table 2

CITY OF ALBANY RAPP ROAD LANDFILL EASTERN EXPANSION RESTORATION MONITORING SCHEDULE—TO BE APPLIED TO EACH PHASE OF THE RESTORATION

						Active Restoration Including Construction & Post-construction Seeding & Planting	Short-term Management																		Long-term Management (>10 Years Long-term Maintenance)																			
	Task	Baseline (2007)				Site Construction	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6				Year 7				Year 8				Year 9				Year 10			
	Quarter	1	2	3	4		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	**Vegetation**																																												
a	Diversity		X	X				X	X			X	X			X	X			X	X			X	X			X	X			X	X			X	X			X	X			X	X	
b	Percent Cover		X	X				X	X			X	X			X	X			X	X			X	X			X	X			X	X			X	X			X	X			X	X	
c	Woody Plant Dist.		X	X				X	X			X	X			X	X			X	X			X	X			X	X			X	X			X	X			X	X			X	X	
d	Wetland Delineation											X				X				X								X								X						X					
2	**Birds**																																												
a	Breeding Surveys		X					X				X				X				X				X				X								X						X					
b	Spring Migratory		X					X				X				X				X				X				X								X						X					
c	Fall & Winter Migratory			X	X				X	X			X	X			X	X			X	X			X	X			X	X			X	X			X	X			X	X			X	X
3	**Amphibians**		X					X				X				X				X				X				X								X						X					
4	**Lepidoptera**		X	X		X		X	X			X	X			X	X			X	X			X	X							X	X			X	X			X	X			X	X	
5	**Fishes**		X	X				X				X				X				X				X				X								X						X					
6	**Hydrology**	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7	**Reporting**		X		X			X		X		X		X		X		X		X		X		X		X		X		X			X			X			X			X			X	X
8	**Target Date Notice of Completion (Application)**																																														X	
9	**Target Dates Certification of Completion (Agencies)**																																															X
10	**HGM/HEP or other Model**				X									X									X							X							X										X
11	**Agency review and approved release**																																														