Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Designs

Shell Beach Invasive Plant Control
Shell Beach, Town of Shelter Island

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1 Executive Summary

The Town of Shelter Island obtained New York State Department of Environmental Conservation (NYSDEC) and U.S Army Corps of Engineers (USACE) permits in 2008-2009 to repair storm damage to Oak Tree Lane by constructing a gabion wall at the west end of the road and installing three new groins to the east of the gabion wall. In conjunction with the shoreline stabilization, the Town identified a goal of implementing a "Strategic Ecological Restoration Plan" to improve ecological conditions and shorebird nesting habitat by removing invasive plant species from Shell Beach. To further that goal, the conceptual habitat restoration plan for Shell Beach identifies stands of invasive plants for recommended removal, identifies native plant species and communities targeted for establishment at Shell Beach, offers recommended methods and specifications for control of invasive plants, identifies un-vegetated areas suitable for planting of native vegetation, and provides cost estimates for the recommended methods of invasive plant control and native plant establishment. This conceptual plan provides detailed descriptions of methods and specifications for inclusion in a potential permit application to NYSDEC and/or to solicit bids from prospective contractors.

Field investigations conducted in May 2012 indicated the presence of approximately 3.6 acres of woodlands dominated by invasive trees, shrubs, and vines (particularly black locust). These woodlands dominated by invasive trees have displaced the herbaceous plants and shrubs typical of maritime dunes and grasslands along Long Island's coasts. In addition, the woodlands degrade the quality of breeding and nesting habitat for piping plover at Shell Beach by providing perching sites for many common plover predators including crows and common grackles. The recommended method for controlling invasive trees and shrubs at Shell Beach is the cutting of the trees and shrubs close to ground level, targeted application of herbicides to the cut stumps, and careful removal of the cut biomass. It is expected that annual monitoring and follow-up herbicide applications would be needed for three to four growing seasons (inclusive of the initial cutting and herbicide application) in order to provide control of the invasive trees and shrubs at Shell Beach. Due to the abundance of native herbaceous plants and woody shrubs in and adjacent to the invasive plant stands at Shell Beach, it is expected that establishment of the target plant communities can be accomplished through natural recruitment of native plants and selective weeding of invasive plants. Native plants suitable for establishment at Shell Beach include herbaceous plants typical of Long Island's maritime dune and grassland communities including Cape American beach grass (*Ammophila breviligulata*), seaside goldenrod (*Solidago sempervirens*), beach pea (*Lathyrus japonica*), little bluestem (*Schizachyrium scoparium*), and bitter panicgrass (*Panicum amarum*). These dune and grassland communities typically feature scattered patches of native shrubs including bayberry (*Morella pensylvanica*), eastern red-cedar (*Juniperus virginiana*), winged sumac (*Rhus copallina*), northern dewberry (*Rubus flagellaris*), and beach plum (*Prunus maritima*).

The conceptual plan and recommendations for invasive plant management at Shell Beach were prepared in 2012 prior to Hurricane Sandy. Hurricane Sandy resulted in significant coastal erosion and flooding on Shell Beach. In response to the erosion damage, the Town of Shelter Island placed clean sand fill on the eroded scarps and slopes at Shell Beach under NYSDEC General Permit #GP-0-12-006. Appendix D was added to the report in March 2013 to reflect post-Sandy conditions. Appendix D provides areas of clean sand fill placed on eroded slopes, recommended plant species and estimates of plant material quantities necessary to re-vegetate these areas, and material and labor cost estimates for re-vegetating these areas.

2 Existing Conditions

2.1 Existing Plant Communities at Shell Beach

Historically, Shell Beach was a narrow sand spit comprised of maritime beaches and shallow tidal flats or sandbars, as shown in aerial imagery from 1954 (Figure 1). The spit's low beach areas were exposed and dry at high tide and the sand bars were submerged at high tide. At high tide, the beach area located at the eastern end of the spit, near the timber bulkhead, would have been a small, sandy island connected to the mainland by shallow sandbars. During storms and astronomical high tides, the entire sand spit was likely submerged.

Oak Tree Lane was constructed in the mid-1960s by importing fill to create a higher elevation area for the roadway. The artificial creation of high elevation areas allowed the colonization of upland plants, particularly woody trees and shrubs, which are not tolerant of the inundation by tides and storms. Non-native trees and shrubs, such as Japanese black pine and autumn olive, may have been planted for soil stabilization purposes after the construction of the road.

Currently, Shell Beach features plant assemblages typical of coastal habitats as beaches, dunes and swales, maritime grasslands and heathlands, and early successional woodlands. There are few discrete boundaries between these community types, rather they gradually transition between each other. There are also scattered patches of tidal wetland vegetation, including high marsh and intertidal marsh, and brackish meadows located on the northern shoreline in the sheltered waters of West Neck Harbor. As described in detail below, some areas of Shell Beach are dominated by native plants and are representative of undisturbed conditions in Long Island's coastal habitats. In other areas of Shell Beach, particularly the early successional woodlands at the eastern end of the peninsula, invasive trees and shrubs are dominant and have substantially altered ecological conditions. Lastly, other locations at Shell Beach possess plant communities that consist of a mixed composition of both native and invasive plants. A complete list of the plant species observed at Shell Beach is provided Appendix A. Representative photographs of Shell Beach ecological communities are provided in Appendix B.

The upper beaches at Shell Beach and the adjacent foredunes are dominated by common native coastal plants including American beach grass (*Ammophila breviligulata*), seaside goldenrod (*Solidago sempervirens*), and beach pea (*Lathyrus japonicas*). Landward of this zone of obligate beach vegetation, plants common to Long Island's maritime grasslands become abundant and are integrated with the beach vegetation. These plants include bayberry (*Morella pensylvanica*), prickly dewberry (*Rubus flagellaris*), little bluestem (*Schizachyrium scoparium*), grass-leaved goldenrod (*Euthamia gramnifolia*), Atlantic golden aster (*Pityopsis falcata*), pinweed (*Lechea maritima*), and sand sedge (*Carex silicea*). A representative photo of this plant community at Shell Beach is shown in Photo A (Appendix B).

Further landward, the reduced impacts of salt spray and windblown sand allow upland invasive plants and weeds to become abundant. The most common invasive plants at Shell Beach are black locust (*Robinia pseudoacacia*), autumn olive (*Elaeagnus umbellata*), Asiatic bittersweet (*Celastrus orbiculatus*), multiflora rose (*Rosa multiflora*), Japanese black pine (*Pinus thunbergii*), and tree of heaven (*Ailanthus altissima*). Herbaceous weeds, such as mugwort (*Artemesia vulgaris*), downy brome (*Bromus tectorum*), narrow-leaved plantain (*Plantago lanceolata*) and yellow rocket (*Barbarea vulgaris*) are common along the road margins.

Several large stands of black locust, encompassing approximately 2.7 acres, are located at the wide eastern end of Shell Beach at the periphery of the sparsely vegetated shorebird nesting area (Photos B and C). Japanese black pine and tree of heaven are mixed with the black locust at the eastern end of these tree stands. The locust trunks provide habitat for climbing vines such as Asiatic bittersweet and Japanese honeysuckle (*Lonicera japonica*) (Photo D). These locust stands give shelter from salt spray and allow invasive herbaceous plants and tree seedlings to grow under the locust canopy, contributing to the reduced abundance of native beach vegetation in these stands. For example, Photos E and F show tree of heaven saplings and *Phragmites australis* shoots in the understory of the locust stands. There are also native plants in the understory of these locusts stands, including bayberry, winged sumac (*Rhus copallina*), and prickly pear (*Opuntia humifusa*) (Photo G), and assemblages of native plants adjacent to the margins of these invasive tree stands. For example, Photo H shows a stand of bayberry shrubs adjacent to a cluster of Japanese black pine. Therefore, efforts to control the locust and other invasive species would allow the existing, but suppressed, native plant communities to develop and expand.

In the central portion of Shell Beach, autumn olive and black locust are found intermittently along the northern and southern road margins and along the base of the slope on the northern side of the road (Photo I). In these areas, the invasive trees and shrubs are found at lower densities and are mixed with abundant growth of native grasses and herbaceous plants and occasional native trees and shrubs.

At the western end of Shell Beach, particularly on the north side of the existing parking area, the steep slope between the roadway and the beach is dominated by invasive shrubs and vines (Photos J and K). This area exhibits a dense stand of invasive vegetation (0.17 acres) consisting of a band of autumn olive, tree of heaven, and black locust at the base of the slope and dense stand of multiflora rose and Asiatic bittersweet rooted both at the base of the slope and on the slope face. The olive and locust may have been intentionally planted for soil stabilization purposes.

2.2 Impacts of Invasive Plants at Shell Beach

The proliferation of invasive trees and shrubs has degraded ecological conditions at Shell Beach. The invasive trees and shrubs at Shell Beach are taller than native beach and dune vegetation (such as American beach grass, little bluestem, bayberry, and beach plum) and typically have rapid growth rates. As a result, these trees have created a canopy that is shading out and displacing the native plants that are typical of Long Island's coastal habitats. The gradual decrease in abundance of native plants will contribute to reduced populations of native insects (such as butterflies, bees, and other pollinators) and wildlife (particularly birds) that feed specifically on native plant species. Second, these invasive trees have fundamentally changed the ecological conditions at Shell Beach. Maritime habitats should be open, wind-swept, and sandy− resulting in high light availability, exposure to salt spray and wind-blown sand, and nutrient-poor, droughty soils. The invasive trees at Shell Beach have created microhabitats that are shady and protected from the wind and salt spray. This displaces native species, such as prickly pear cactus and little bluestem that require high light conditions, and facilitates the growth of invasive weeds. In addition, many of the Shell Beach's invasive trees and shrubs are nitrogen-fixers, such as black locust and autumn olive. Nitrogen-fixing plants have the physiological capacity to utilize atmospheric nitrogen and convert it into nitrogen forms that other plants can use. As a result, these nitrogen-fixers increase nitrogen availability in the soil. Long Island's native dune and grassland plants are well adapted to nutrient poor, sandy soils; therefore, the extra nutrients provided by locust and olive can facilitate the growth of invasive weeds. In addition, pet waste also serves as a minor source of additional nutrients to plant communities adjacent to roads. Lastly, the locust stands are adjacent to 2.1 acres of sparsely vegetated, sandy substrate that serves as nesting habitat for piping plovers (*Charadrius melodus*). The nearby locust stands provide perching sites for many common predators

of piping plovers including crows (*Corvus sp.*), common grackles (*Quiscalus quiscula*), and kestrels (*Falco sparverius*). Therefore, removal of the invasive woodland stands would increase the quality of the breeding and nesting habitat for piping plover and allow for replacement with native plant communities typical of Long Island's coasts.

3 Recommendations for Invasive Plant Control

The Town of Shelter Island (Town) obtained NYSDEC and USACE permits in 2008-2009 to repair storm damage to Oak Tree Lane by constructing a gabion wall at the west end of the road and installing three new groins to the east of the gabion wall. In conjunction with the shoreline stabilization, the Town identified a goal of implementing a "Strategic Ecological Restoration Plan" to improve ecological conditions and shorebird nesting habitat by removing invasive species from Shell Beach (Appendix C).

This conceptual plan and supporting report provide methods and specifications for the implementation of the Town's Strategic Ecological Restoration Plan and may be used to obtain necessary authorization from the NYSDEC and to solicit bids from prospective contractors. The provided restoration plans target the removal of invasive plants in the 2.7 acres of black locust-dominated woodlands to promote a transition to native maritime grassland habitats. Invasive plants shall also be targeted in another 0.9 acres that are mostly dominated by native plants, to prevent further invasive growth and habitat degradation. Invasive plant removal would aim to replace the locust woodlands with maritime dune and grassland habitats shown in Photo A. Conceptual plans and recommendations take into account the Town's needs for equipment access to the beach for periodic maintenance of the shoreline protection structures and emphasize the maintenance of stable vegetated slopes to the north of the existing parking area.

As described in Section 2 (*Existing Conditions*), the relative abundance of native and invasive plants varies between different parts of Shell Beach. For that reason, a single strategy for controlling invasive plants is not suitable for Shell Beach. The central and eastern portions of the peninsula have dense stands of invasive plants, but also feature adequate existing native vegetation to allow for dispersal and recruitment of these native plants. The peninsula is widest and highest in elevation at its eastern end; accordingly, coastal erosion poses little threat to the eastern end of Oak Tree Lane. In these areas, the existing native vegetation can be allowed to gradually replace, through natural recruitment, the removed invasive plants. Several small areas in the central portion of the peninsula exhibit recent coastal erosion and have little vegetation (either native or invasive). In these areas, the planting of native vegetation is recommended to minimize the potential for localized erosion. Lastly, in small areas in the western portion of Shell Beach, existing vegetation is almost entirely comprised of invasive plants and there are few native plants. These areas also have steep slopes leading from the road to the narrow beach. These areas are at greater risk of erosion and, therefore, the benefits of maintaining the root systems of invasive plants likely outweigh the environmental benefits of replacing these species with native vegetation. In these areas, invasive plant control is not recommended.

3.1 Evaluation of Alternatives for Invasive Plant Control

Common methods for eradication of invasive plants include mechanical techniques, such as repeated cutting, hand-pulling, or mowing; the use of chemical herbicides; and prescribed burning. As described below, the cutting of invasive plants close to ground level and targeted application of herbicides to the cut stumps is the recommended management method for the woody invasive plants at Shell Beach.

Several alternative control methods were considered, but ultimately rejected. Cutting alone is not a viable management method at Shell Beach as nearly all of its woody invasive plants re-sprout vigorously from roots (root suckering) or cut stumps (stump sprouting). Repeated high mowing several times per growing season, over many years, may prevent the re-growth of invasive trees and shrubs. However, this management alternative was rejected because 1) it will also prevent the colonization of native shrubs (such as bayberry, beach plum, or winged sumac), 2) the repeated use of mowing equipment will damage and prevent further growth of fragile ground vegetation present at Shell Beach (such as reindeer lichen and prickly pear), and 3) it would be costly and inconvenient to mow these areas frequently for many years. Prescribed burning was also rejected as a management method as 1) it is inconsistent with the recreational uses and aesthetic benefits of Shell Beach and 2) burning cannot be used to specifically target the invasive plants at Shell Beach.

It is important to emphasize that a single herbicide treatment after initial cutting of woody trees and shrubs will not result in complete eradication of the target invasive plants due to 1) missed plants during the initial herbicide application, 2) persistence of target plant species, which can sometimes re-sprout after initial application, and 3) germination of invasive plants from seed. Accordingly, annual monitoring is necessary to identify re-growth of invasive plants and conduct follow-up herbicide treatments as needed. It is expected that annual monitoring and follow-up herbicide applications will be needed for three to four years (inclusive of the initial cutting and herbicide application) with the expected work effort greatly reduced two years after the initial cutting and herbicide application. In a local example of herbicide control of woody invasive plants, Fire Island National Seashore found that herbicide application for three years was necessary to control autumn olive at the William Floyd Estate (J. Raphael, pers. comm.).

3.2 Use of Natural Recruitment of Native Plants

While a primary goal of this project is to restore native plant communities, planting of native vegetation is not recommended for much of Shell Beach. Due to the abundance of native herbaceous plants and woody shrubs in and adjacent to the invasive plant management areas, it is expected that establishment of the target plant communities can be accomplished through natural recruitment of native plants and selective weeding of invasive plants. Natural recruitment shall occur through the growth of existing suppressed plants within the invasive plant stands, germination of the existing seed bank within the invasive plant stands, and seed dispersal from nearby native plants into the invasive plant control areas. The benefits of site restoration through natural recruitment include the following:

- Plant distribution and composition at the Shell Beach will be determined naturally by plant physiological tolerances and competition between plant species rather than artificially prescribed by project planners.
- Reduced project costs by minimizing/eliminating costs of purchasing plant material from nurseries and labor costs associated with installation of plant material.
- Reduced project maintenance costs by minimizing/eliminating need to irrigate plant material
- Natural recruitment ensures that the plants established at Shell Beach are local genotypes rather than non-local populations/genotypes. Local genotypes are likely to be better adapted to the soil and climatic conditions of Shell Beach than non-local source material supplied by commercial nurseries.

3.3 Target Plant Communities

Identification of target native plant species and communities is an important component of invasive plant management, as this facilitates evaluation of the success of the project and guides the maintenance of the site. In this case, target native plants species are those that 1) are growing well at Shell Beach, thereby demonstrating compatibility with the site's soil and climate conditions, and 2) are native to eastern Long Island's coastal habitats. Upland areas dominated by invasive trees and shrubs at Shell Beach are suitable for establishment of native dune vegetation and maritime grassland communities. Native maritime grasslands are dominated by little bluestem (*Schizachyrium scoparium*), common hairgrass (*Deschampsia flexuosa*), and poverty grass (*Danthonia spicata*), with scattered patches of heath and shrubs including bayberry (*Morella pensylvanica*), eastern red-cedar (*Juniperus virginiana*), winged sumac (*Rhus copallina*), northern dewberry (*Rubus flagellaris*), and beach plum (*Prunus maritima*) (Edinger et al., 2002). Sparsely vegetated gaps in these grasslands are likely to exhibit reindeer lichen (*Cladinia rangiferina*) and herbaceous plants such as grass-leaved goldenrod (*Euthamia gramnifolia*), Pennsylvania sedge (*Carex pensylvanica*), white-topped aster (*Aster paternus*), pussy toes (*Antennaria plantaginifolia*), and golden aster (*Pityopsis falcata*) (Edinger et al., 2002). Native beach and dune vegetation is also likely to colonize these areas, particularly the seaward edges; plant species are likely to include American beach grass (*Ammophila breviligulata*), seaside goldenrod (*Solidago sempervirens*), beach pea (*Lathyrus japonica*), and beach pinweed (*Lechea maritima*). Many of these target herbaceous plants and woody plants are found at Shell Beach within and adjacent to the stands of invasive trees. Therefore, adequate seed sources and parent material exist for native plants to replace invasive plants after the recommended control methods are implemented. Photo A portrays the target maritime grassland community with scattered red-cedar, bayberry, and dewberry that this project would aim to establish at Shell Beach.

3.4 No Management Areas

On the north side of Oak Tree Lane, opposite of the gabion wall, the steep slope between the roadway and the beach is dominated by invasive shrubs and vines (Photos J and K). This area is approximately 400 feet in length and includes approximately 7,300 sq ft (0.17 acres) of invasive vegetation. There is a narrow (10-15 feet wide) band of black locust and autumn olive at the toe of the slope along much of this area. The eastern end of this area has a dense stand of multiflora rose and Asiatic bittersweet rooted both at the toe of the slope and on the slope face. However, some portions of this area have native woody vines on the slope including prickly dewberry, Virginia creeper (*Parthenocissus quinquefolia*), and poison ivy (*Toxicodendron radicans*).

Due to the steep slope and relatively narrow beach width in these areas, it is a priority to maintain the soil stabilization benefits of the existing vegetation. The soil stabilization function of the shrubs and vines is not dependent on whether these species are native or invasive. In this area, removal of the invasive shrubs and vines is not recommended due to the potential for erosion and rilling of the slope in the interval between the removal of invasive plants and establishment of native vegetation. At a public meeting on August 21, 2012, the Town of Shelter Island Board indicated a preference for maintaining invasive vegetation if the vegetation was providing important soil stabilization benefits. Replacement of these invasive plants with native vegetation would provide comparatively small ecological benefits due to the small size of this area (0.17 acres).

3.5 Access Areas

The Town of Shelter Island periodically excavates accumulated sand from the eastern terminus of Shell Beach and transports the sand to the western end to replenish the beach in front of the gabion wall. This

work is authorized under existing permits from the NYSDEC and USACE. Sand is transported along Oak Tree Lane. In order to facilitate continuation of these maintenance activities, it is recommended that two access areas (approximately 40 feet in width) be left unvegetated. The eastern access area would allow equipment to get from Oak Tree Lane to the eastern end of the Shell Beach. The western access area would allow equipment to access the base of the gabion wall and the western beach and groins.

4 Invasive Plant Management Methods and Specifications

This section provides narrative specifications for proper implementation of the recommended invasive plant control methods. These specifications and the accompanying conceptual plan are adequate for submission to the NYSDEC for project review and permitting, and could be used to solicit bids from prospective contractors to complete the recommended work.

4.1 High and Low Density Invasive Plant Control Areas

4.1.1 Herbicide Application

It is recommended that herbicide application to cut stumps be utilized to control invasive trees and shrubs in the *High Density* and *Low Density Invasive Woody Tree and Shrub Control Areas* (Shell Beach Invasive Plant Management Plan, Sheets 1-4). No herbicides should be applied to native plants or within the *Sensitive Native Plant and Lichen Protection Area*. Herbicide application should abide by the following specifications.

1. Trees and shrubs of the following species shall be cut as close to ground level as possible (12" minimum):
    - Black locust (*Robinia pseduoacacia*)
    - Japanese black pine (*Pinus thunbergii*)
    - Autumn olive (*Elaeagnus umbellata*)
    - Multiflora rose (*Rosa multiflora)*
    - Tree of heaven (*Ailanthus altissima*)
    - Asiatic bittersweet (*Celastrus orbiculatus*)
    - Shrub honeysuckle (*Lonicera sp.*)
    - Japanese honeysuckle (*Lonicera japonica*)

2. All cut biomass shall be removed from the project site. For methods regarding the removal of woody biomass, refer to Section 4.1.2,*Cutting and Biomass Removal*.
3. Cutting and herbicide application shall occur between August 1 and September 30 to minimize the potential for disturbance to non-target plant species during cutting and removal or herbicide application.
4. Initial herbicide applications shall be "cut stump" application of 20-30% triclopyr solution (Garlon4 Ultra or equivalent) in basal oil.
5. No herbicides shall be applied in tidal wetland areas.
6. In cases where an invasive vine (such as Asiatic bittersweet or Japanese honeysuckle) is growing on an invasive tree, both the tree and vine should be cut to ground level and herbicides applied to both cut stems.
7. Herbicide solutions shall be mixed on the existing roadway and not in areas of vegetation or the open beach.
8. Herbicides shall be applied by a New York State certified herbicide applicator.

9. Herbicide application to cut stumps should occur immediately after cutting (within 1 hour) to ensure maximum uptake of the herbicide.
10. Herbicide shall be applied using a wickstick, sponge-type applicator, paintbrush, or equivalent.
11. Herbicide shall be applied in accordance with the manufacturer's instructions and NYSDEC regulations.
12. Herbicide should not be applied if air temperature is less than 50ºF or rain is expected within the next 24 hours.
13. No wind speed restrictions are necessary as herbicides shall be applied to cut stumps directly without a sprayer. If a sprayer is utilized for follow-up herbicide treatments, herbicides shall not be applied if wind speed exceeds 8 mph.
14. The cut stump and bark below the cut shall be thoroughly wetted. However, no runoff from the stump's bark or incidental application of the herbicide to ground or nearby vegetation should occur.

4.1.2 Cutting and Biomass Removal

It is recommended that cutting and removal of invasive tree and shrub biomass in the *High Density* and *Low Density Invasive Woody Tree and Shrub Control Areas* be conducted as follows to minimize impacts to existing native vegetation.

1. Invasive trees shall be cut to ground level with motorized hand tools (i.e. chain saw, long-handled pruner, or handsaws). All cutting and stockpiling of cut biomass shall be conducted in a manner to avoid disturbance to native vegetation.
2. Due to the fairly large size of some of the target invasive trees, appropriate arboricultural practices and safety equipment shall be employed to minimize risk of injury to workers.
3. To avoid disturbance to native vegetation, no vehicles or small heavy equipment are permitted within the *High Density* and *Low Density Invasive Woody Tree and Shrub Control Areas*.
4. All cut trunks, stems, and branches shall be removed from the management areas by hand. Cut biomass shall be carried by hand to the road or the beach, where biomass can be loaded into vehicles for removal.
5. A qualified ecologist or botanist shall supervise the cutting and removal of invasive trees and shrubs to minimize disturbance to native vegetation.
6. All cut biomass shall be disposed of at a licensed upland disposal or recycling facility.

4.1.3 Follow-up Herbicide Applications

Several of the target plant species (especially black locust, autumn olive, and Asiatic bittersweet) may re-sprout after the initial herbicide application through root suckering. Other invasive species, such as multiflora rose, produce large quantities of seeds and may re-germinate from seeds in the soil. Lastly, some herbaceous invasive species, such as mugwort and *Phragmites*, may attempt to colonize the areas cleared of invasive trees and shrubs. Therefore, annual monitoring of high- and low-density controls is necessary to identify re-growth shoots and any new invasive plants for annual maintenance weeding or herbicide application. Re-growth shoots and newly germinating plants should be controlled using a foliar herbicide application due to the small size of re-growth shoots as described below. Again, project specifications require that the herbicide applicator be cautious in herbicide use and avoid incidental application to native vegetation. Very small plants can be removed mechanical by hand-pulling or digging with a shovel.

1. Foliar herbicides shall be applied to any stands of target invasive plants identified by the project biologist. Herbicides shall consist of 1-2% glyphosate solution (v/v) in water with 0.5% non-ionic surfactant (Accord or Rodeo).
2. Foliar herbicides shall be applied between August 1 and September 30
3. Herbicides may only be applied if air temperature is greater than 50º F, no rain is predicted for the next 24 hours, and wind speeds are less than 8 mph.
4. Herbicides shall be applied with a backpack sprayer or wick stick.
5. Leaves and green stems shall be thoroughly wet, but not to the point of runoff.
6. It is expected that control of invasive wood plants shall be achieved after three to four growing seasons of herbicide treatment and follow-up monitoring and spot treatments of foliar herbicides.
7. No herbicides are proposed for tidal wetland areas.
8. Herbicide solutions shall be mixed on the existing roadway and not in areas of vegetation or the open beach.
9. Herbicides shall be applied by a New York State certified herbicide applicator.
10. Herbicides shall be applied in accordance with the manufacturer's instructions and NYSDEC regulations.

4.2 Native Plant Restoration Areas

Three unvegetated or sparsely vegetated areas have been identified where planting of native vegetation would provide soil stabilization and erosion control benefits. These areas are shown on Sheets 1 and 4 of the Shell Beach Invasive Plant Management Plan and are labeled *Native Plant Restoration Areas.* These sites are located on the southern shore of Shell Beach and exhibit signs of recent erosion. The eastern area is 0.08 acres in size, the central area is 0.12 acres in size, and the western area is 0.07 acres in size. The western area consists of exposed sand along the top of the boulders placed to stabilize the edge of the western end of Oak Tree Lane. Therefore, it may not be feasible to plant vegetation in this area until the Town's groin and shoreline improvements are completed.

The following plant species are suitable for installation at these locations:

- Cape American beach grass (*Ammophila breviligulata*)- 2" plugs or bare root culms on 18" centers
- Seaside goldenrod (*Solidago sempervirens*)- 2" plugs on 18" centers
- Beach pea (*Lathyrus japonica*)- 2" plugs on 18" centers

4.2.1 Plant Quantities

Based on the areas of each of these areas, the following plant quantities would be required.

Table 1: Plant Quantities for Native Plant Restoration Areas

Native Planting Area	*Area (Sq. Ft.)*	*Plant Quantity*	*Species Composition*
Eastern Planting Area	3,581	1,591	1,050 Ammophila plugs (or 2,100 bare root culms), 541 Solidago and/or Lathyrus plugs
Central Planting Area	5,311	2,360	1,558 Ammophila plugs (or 3,116 bare root culms), 802 Solidago and/or Lathyrus plugs
Western Planting Area	2,969	1,319	1,319 Ammophila (or 2,638 bare root culms)

4.2.2 Planting Specifications

1. Plugs/culms shall be installed on the exposed/eroded dune face, in any observed bare areas above the top of the slope face, and in a 5 ft wide band seaward from the toe of the slope.
2. Two bare root culms shall be planted per planting hole on 18 inch centers. One herbaceous 2 inch plug shall be planted per planting hole on 18 inch centers.
3. *Ammophila* bare root culms must be installed between March 1 and April 1. Plugs may be installed between April 1 and May 15. The early planting is necessary to avoid or minimize irrigation requirements during the summer months.
4. Delivered plugs should have labels/tags indicating botanical name, common name, and nursery.
5. 85% survivorship of the planted vegetation is required after the end of two growing seasons. Contractor shall be responsible for replanting once during the appropriate planting season to achieve a minimum of 85% of the planted quantity.
6. Plant should have well developed root systems and shall be free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement, and abrasion. Roots should be sufficiently well-developed for the root mass to retain its shape and hold together when removed from the trays or containers.
7. Plants shall be furnished in sizes indicated. Acceptable plants shall be well-shaped, full, and symmetrical plants of uniform color and texture.
8. Inorganic fertilizer shall be applied in each planting hole for herbaceous plugs.
9. Fertilizer shall be controlled release commercial grade, free flowing, uniform in composition, and consist of an 8-6-12 nitrogen-phosphorus-potassium ratio. 2.5 oz of fertilizer shall be placed in each planting hole for bare root culms or plugs. The fertilizer shall be derived from sulphur coated urea, urea formaldehyde, plastic or polymer coated pills or isobutylenediurea. Fertilizer shall be balanced with the inclusion of trace minerals and micro-nutrients.
10. Plants not installed on the day of arrival at the project site shall be stored and protected in designated areas from direct exposure to wind and sun. Plants must not be stored on-site for more than 7 days before planting.
11. Bare root culms not installed on the day of arrival shall be heeled into the sand at an upland location to avoid desiccation of culms.
12. Plugs not installed on the day of arrival shall be watered (with freshwater) to keep roots moist.
13. For bare root culms and herbaceous plugs, fertilizer shall be placed in the bottom of each planting hole prior to placing a plug.
14. Bare root culms shall be planted at least 8 inches deep. Plants shall be set plumb, with the root system oriented downward, and held in position until sufficient soil has been firmly placed by hand around the culm. It shall be unacceptable to step on or around planting holes for the purpose of placing backfill.
15. Plugs shall be planted at a depth of no more than 1 inch deeper than grown in the nursery. The top of the rootstock mass shall be a minimum of 1 inch below the soil surface. Plants shall be set plumb, with the root system oriented downward, and held in position until sufficient soil has been firmly placed by hand around the root mass. The plant shall be set even with or slightly higher than the surrounding grade. It shall be unacceptable to step on or around planting holes for the purpose of placing backfill.

4.3 Sensitive Native Plant and Lichen Protection Area

A 9,000 sq. ft. area of native herbaceous plants and lichens is located on the northern side of Shell Beach near the end of Oak Tree Lane. Due to the openness of this area, it is a concern that laborers may trample

this vegetation during the removal of trunks and branches cut from the adjacent invasive tree stands. The following measures are proposed to avoid disturbance to this sensitive plant assemblage:

1. Supervision of tree removal and herbicide application by a qualified ecologist or botanist.
2. Installation of temporary symbolic fencing to prevent trampling of this area.

Temporary Symbolic Fencing Specifications:

1. Symbolic fencing must be installed prior to the commencement of invasive tree cutting in the *High Density Invasive Tree/Shrub Control Areas*.
2. Fencing posts shall be 4-6' carconite posts, small gauge steel U-posts, 2" width wooden stakes, or equivalent. Most importantly, posts should be easy to carry, install, and remove.
3. Fence posts spacing should be no more than 30' on center and installed along the perimeter of the *Sensitive Native Plant and Lichen Protection Area.*
4. Symbolic fencing twine, masonry twine or equivalent, shall be strung between fence posts and marked with brightly colored flagging tape.
5. Fencing will be removed after the completion of the initial tree cutting and herbicide application. Fencing does not need to be re-installed during maintenance herbicide application in subsequent growing seasons.

4.4 Topsoil Removal Area

As part of the last completed road stabilization project, topsoil was placed on top of the gabion wall and planted or seeded with various wildflowers, presumably black-eyed susan (*Rudbeckia sp.*) and others. The topsoil has become dominated by invasive weeds (particularly mugwort), which have outcompeted the planted/seeded wildflowers. This upper cap to the gabions is no longer attractive and should be removed as it serves as a source of mugwort and weed seeds. This could be accomplished by simply scraping the topsoil of the gabions with a small skidsteer and disposing at an off-site location. No additional soil or planting are recommended for the gabions, as there is little chance of establishing native vegetation in a thin soil or sand layer on the gabion wall and adjacent to the roadway and parking area. During the interim progress meeting, it was indicated that the topsoil serves as a berm preventing vehicles from driving on the gabion wall and the tall weeds growing on the topsoil act as a fence discouraging people from walking on the top of the gabions. For these reasons, the Town of Shelter Island may decide not to implement this restoration recommendation.

4.5 Annual Monitoring and Reporting

Annual monitoring of the *High Density* and *Low Density Invasive Woody Tree and Shrub Control Areas* by a qualified ecologist or botanist is necessary to 1) assess the need for follow-up herbicide applications and identify areas of invasive plant growth, 2) evaluate the success of invasive plant control actions, 3) fulfill any necessary monitoring reporting requirements imposed by the NYSDEC or Town of Shelter Island, and perhaps 4) assess contractor's fulfillment of any survivorship guarantees.

For purposes of assessing the need for follow-up herbicide applications, annual monitoring should be conducted in the months of July-August to allow for herbicide application between August 1 and September 30. Monitoring personnel should thoroughly inspect each invasive plant management area to detect any re-growth shoots, root suckers, or newly germinated invasive plants. Any observed invasive plants should be labeled with flagging tape or equivalent to allow follow-up herbicide or weeding crews to locate invasive

plants. Annual monitoring will likely need to be conducted for three growing seasons after the initial cutting and herbicide application.

In order to evaluate the success of invasive plant control actions or fulfill reporting requirements by regulatory agencies, the following monitoring protocols and evaluation criteria are recommended.

- After four growing seasons, the High Density Invasive Tree/Shrub Control Area shall have no more than 15% coverage of the target invasive plant species. This Management Area is 114,959 sq ft (2.64 acres); accordingly, the project shall be determined successful if no more than 17,250 sq ft (0.40 acres) of this area is dominated by invasive plants. Stands of invasive trees, shrubs, or vines can be mapped annually with a hand-held GPS and compared to the 2.64 acre management area. The mapped invasive plant stands and percent of the management area could be used as both the evaluation of control success and component of annual reports to regulatory agencies.
- At least ten (10) permanent photo monitoring points should be established at Shell Beach and each denoted with a permanent stake. Photo monitoring points should be located in the high- and low-density plant control areas and the native plant restoration areas. During annual monitoring, the project ecologist should collect photographs, from each cardinal direction, from each of these photo points.
- Success criteria for native plant restoration areas should be greater than 85% survivorship of any planted herbaceous plants two growing seasons after planting (not including the effects of coastal storms on vegetated planted on the face or toe of a dune slope).

5 Cost Estimates for Recommended Invasive Plant Control and Native Plant Restoration Actions

Herbicide and landscaping contractors and nursery suppliers were contacted to provide preliminary cost estimates for herbicide application, cutting and removal of invasive trees and shrubs, plant material costs, and installation of plants. Labor costs for tree cutting and biomass removal and planting of native plugs assume prevailing wage rates.

5.1 Herbicide Application Costs

Table 3: Estimated Invasive Plant Control Costs

Action	*Cost*
Year 1: Herbicide Application to Cut Stems of Invasive Trees and Shrubs	$8,500-$9,500
Year 1: Cutting of Invasive Trees and Shrubs and Removal of Biomass	$46,000
Year 2: Follow-up Herbicide Application to New and Re-Sprouting Shoots	$2,250
Year 3: Follow-up Herbicide Application to New and Re-Sprouting Shoots	$2,250
Year 4: Follow-up Herbicide Application to New and Re-Sprouting Shoots	$1,550
Total	$60,000-$62,000

5.2 Native Plant Restoration Costs

Table 4: Estimated Native Planting Costs

Item	*Cost*
Plant Material (Eastern Area)	$780-$1,080

Plant Material (Central Area)	$1,170-$1,600
Plant Material (Western Area)	$525-$900
Labor	$1,200-$2,400
Total	$3,600-$6,000

5.3 Estimated Topsoil Removal Costs

Table 5: Topsoil Removal Costs

Item	*Cost*
Removal of 80 cy of Topsoil	$4,000
Labor and Equipment	$1,500
Total	$5,500

6 Low Priority Restoration Actions

There are a number of additional restoration actions that were considered for implementation at Shell Beach. These actions were not included as they provide limited ecological benefits and/or are expensive for the expected ecological benefits. These actions include the following:

Phragmites Management at East End of Shell Beach: A small stand of low-vigor *Phragmites* (1,500 sq ft) is located to the northeast of the Sensitive Native Plant and Lichen Protection Area. Herbicide application to this *Phragmites* stand is not recommended as these plants are unlikely to spread to the nearby wetland or upland habitats. However, any *Phragmites* that colonize the high density invasive plant control area after the removal of the woody trees and shrubs should be controlled via the use of herbicides.

Poison Ivy Management: During the control of invasive trees, shrubs, and vines, foliar herbicides could be applied to reduce the abundance of this irritating, but native, plant. The control of poison ivy would be undertaken to facilitate recreational uses of Shell Beach rather than improving ecological conditions. Poison ivy management was not included in the restoration recommendations as, due to the abundance of poison ivy at Shell Beach, control through foliar herbicides would increase the costs of restoration, while not providing additional ecological benefits.

Slope Restoration and Planting: A small area on the north side of Oak Tree Lane (approximately 60 feet in length) has a steep eroded slope (approximately 6-7 ft in height) from the roadway to the beach. This eroded slope is too steep for the planting of herbaceous plugs. This area could be restored through the import of clean sand fill to provide a stable slope and re-planting of the restored face with native beach plants (such as beach grass, coastal panic grass, seaside goldenrod, and beach pea). Due to the need for import of sand fill and equipment to place and grade the fill, this restoration action would be expensive relative to its ecological benefits. If undertaken, this action would be conducted to protect and stabilize the northern margin of Oak Tree Lane. Accordingly, this action was not included in the habitat restoration recommendations.

7 Literature Cited

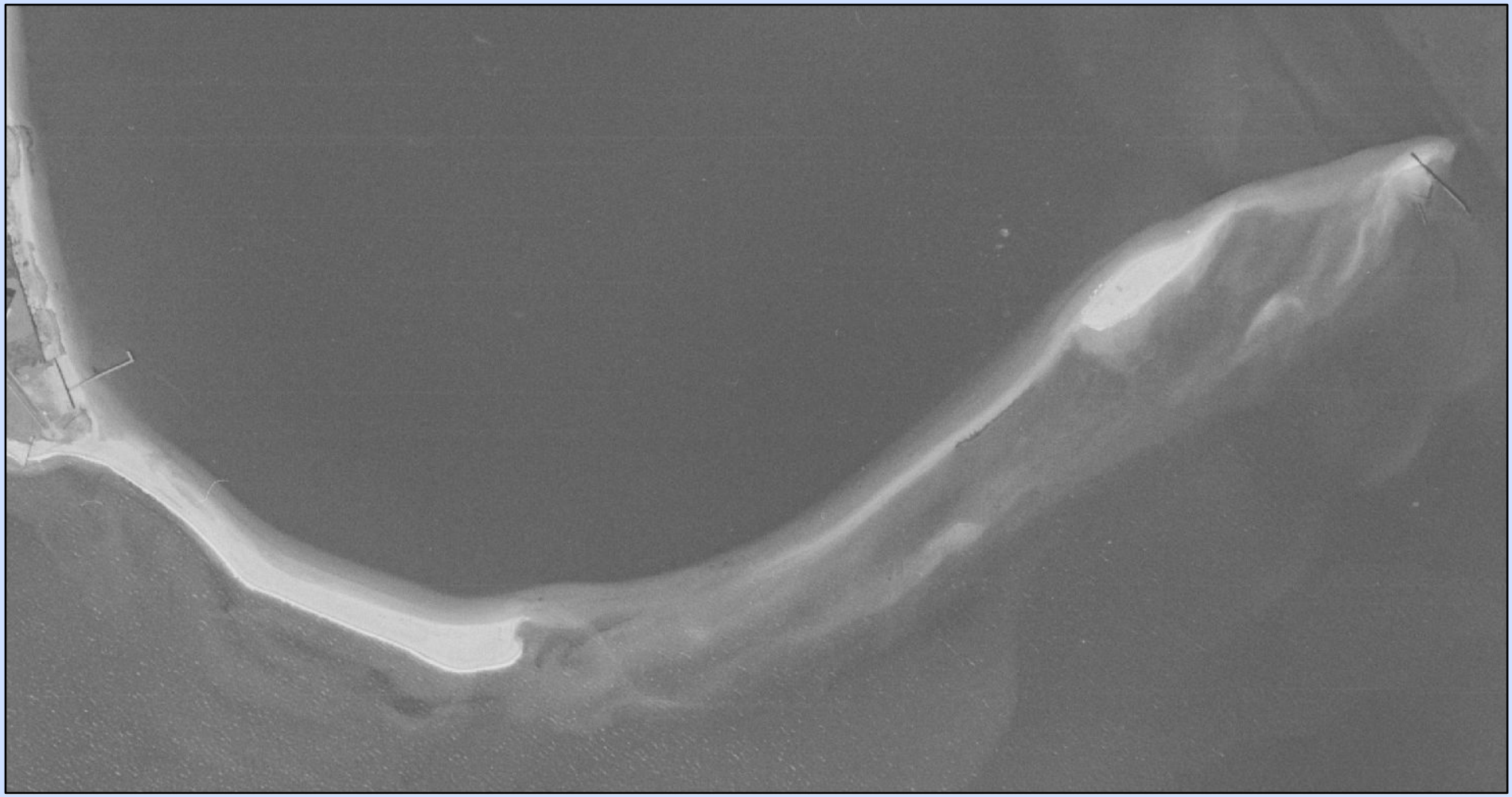
Edinger GJ, DJ Evans, S Gebauer, TG Howard, DM Hunt, and AM Olivero. 2002. Ecological Communities of New York State. 2nd edition. New York Natural Heritage Program-NYSDEC. Albany, New York.

8 List of Preparers

William Bowman, PhD, Land Use Ecological Services, Inc.
Kelly Risotto, Land Use Ecological Services, Inc.

Figure 1. 1954 Aerial Photograph

Shell Beach, Shelter Island



NOTES:

1. Date of Photography: 3/1/1954
2. Data Source: USGS (Earth Explorer)

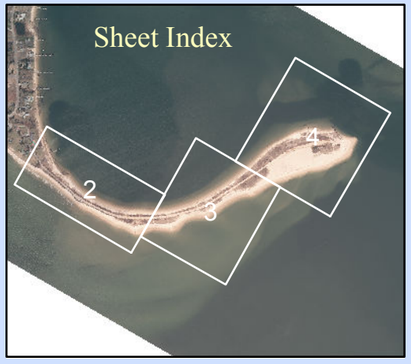
Prepared By:	Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763	Project:	Shell Beach Invasive Plant Management Plan
		For:	Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project
Drawn By:	K. Risotto	Scale:	NTS
Date:	12/21/2012	Revisions:	

Shell Beach Invasive Plant Management Plan

Town of Shelter Island

NOTES:

1. Tidal Wetland Boundary delineated by W.P. Bowman, Land Use Ecological Services, Inc. on May 19, 2012.
2. Base Map: 2010 Orthoimage (NYSOCS).
3. Coordinate System: NAD 1983 UTM Zone 18N (equivalent to Long Island State Plane coordinate system).



- Tidal Wetland Boundary
- Temporary Symbolic Fencing During Construction
- High Density Invasive Woody Tree/Shrub Control Area
- Low Density Invasive Woody Tree/Shrub Control Area
- Native Plant Restoration Area
- Sensitive Plant and Lichen Protection Area
- Topsoil Removal from Existing Gabion Wall
- Protected Shorebird Nesting Area

Sheet 1: Overall Plan

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Drawn By:	K. Risotto	For:	Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project
Date:	12/20/2012	Scale:	As Noted
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N

1 inch = 150 feet

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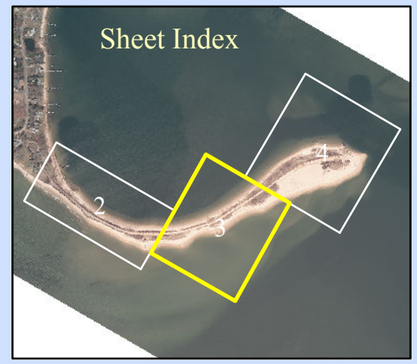

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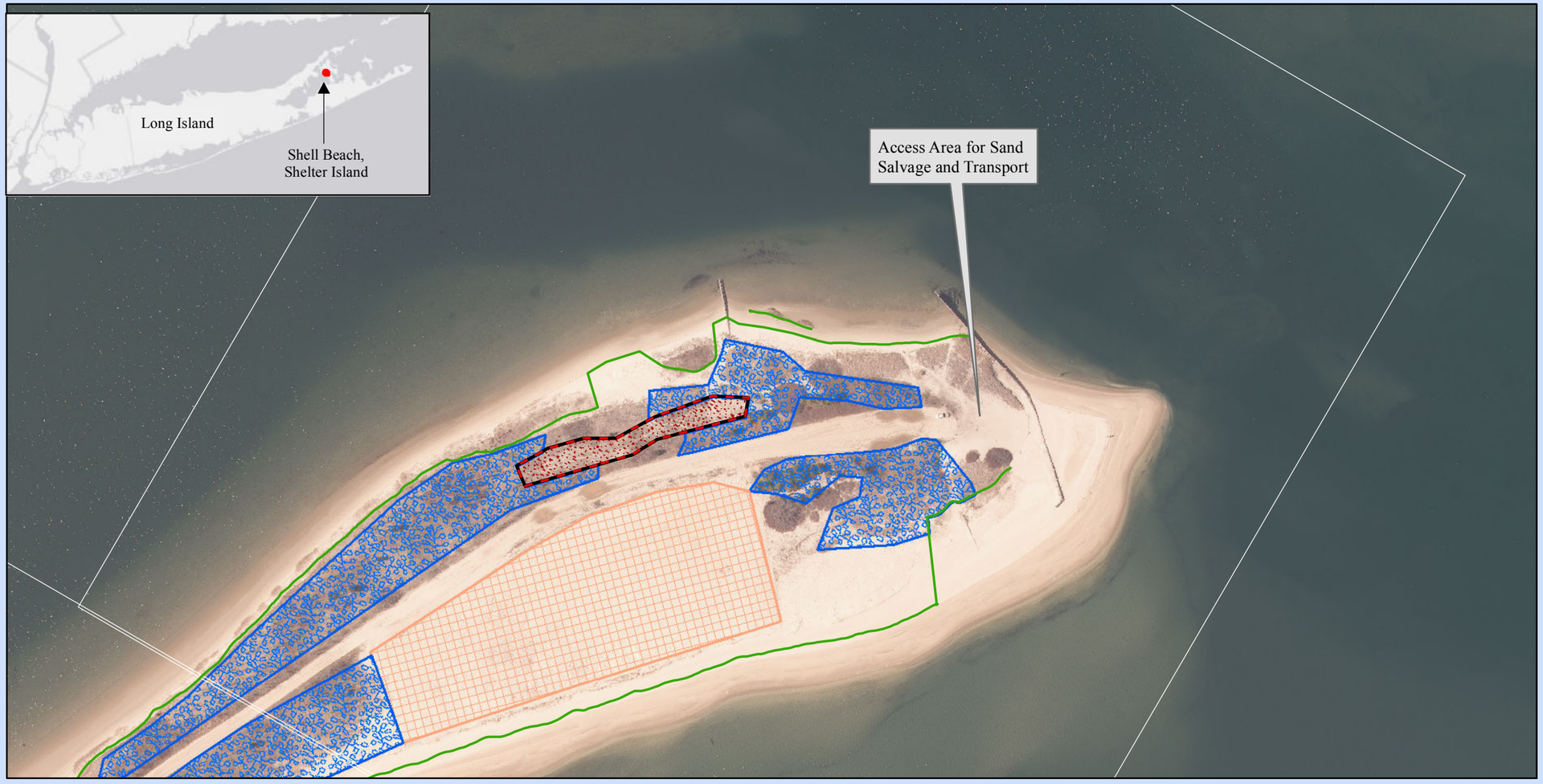
Shell Beach Invasive Plant Management Plan

Town of Shelter Island



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Shell Beach Invasive Plant Management Plan

Town of Shelter Island

Project Specifications

Herbicide Application:

Invasive trees and shrubs shall controlled in the following manner in both *High Density* and *Low Density* Management Areas. No herbicides shall be applied in the plant protection area.

Trees and shrubs of the following species shall be cut as close to ground level as possible (18" minimum):

Black Locust (*Robinia pseduoacacia*) Japanese Black Pine (*Pinus thunbergii*) Autumn Olive (*Elaeagnus umbellata*) Multiflora Rose (*Rosa multiflora)*
Tree of Heaven (*Ailanthus altissima*) Asiatic Bittersweet (*Celastrus orbiculatus*) Shrub Honeysuckle (*Lonicera sp.*)

All cut biomass shall be removed from the project site. For methods regarding the removal of woody biomass refer to the following *Cutting and Removal Methods* section.
Cutting and herbicide application shall occur between August 1 and September 30 to minimize the potential for disturbance to non-target plant species during cutting and removal or herbicide application.
Initial herbicide applications shall be "cut stump" application of 20-30% triclopyr solution (Garlon4 Ultra) in basal oil.
Herbicides shall not be applied to native vegetation.
No herbicides shall be used in tidal wetland areas.
In cases where an invasive vine (such as Asiatic bittersweet) is growing on an invasive tree, both the tree and vine should be cut to ground level and herbicides applied to the cut stumps.
Herbicide solutions shall be mixed on the existing roadway and not in areas of vegetation or the open beach.
Herbicides shall be applied by a New York State certified herbicide applicator.
Herbicide application to cut stump should occur immediately after cutting (within 1 hour) to ensure maximum uptake of the herbicide.
Herbicide shall be applied using a wickstick, sponge-type applicator, paintbrush, ore equivalent.
The Herbicide shall be applied in accordance with the manufacturer's instructions and the NYSDEC regulations.
Herbicide should not be applied if air temperature is less than 50ºF or rain is expected within the next 24 hours. No wind speed restrictions (typically 8 mph) are necessary as herbicides shall be applied to cut stumps directly without a sprayer. If a sprayer, is utilized for follow-up herbicide treatments, herbicides shall not be applied if wind speed exceeds 8 mph.
The cut stump and bark below the cut shall be thoroughly wetted down to the root collar. However, no runoff from the stump's bark or incidental application of the herbicide to ground or nearby vegetation is authorized.

Cutting and Removal

Invasive trees shall be cut to ground level with motorized hand tools (i.e. chain saw, long-handled pruner, or handsaws). All cutting and stockpiling of cut biomass shall be conducted in a manner to avoid disturbance to native vegetation.
Due to the fairly large size of some of the targeted trees, appropriate arboricultural practices and safety equipment shall be employed to minimize risk of injury to workers.
To avoid disturbance to native vegetation, no vehicles or small heavy equipment (i.e. skidsteer) are permitted within the restoration areas.
All cut trunks, stems, and branches shall be removed from the management areas by hand. Cut biomass shall be carried by hand to the road or the beach, where biomass can be loaded into vehicles for removal.
A qualified ecologist or botanist shall supervise the cutting and removal of invasive trees and shrubs to minimize disturbance to native vegetation.
All cut biomass shall be disposed of at a licensed upland disposal or recycling facility.

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	Project: Shell Beach Invasive Plant Management Plan For: Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project Scale: NTS Revisions:

Shell Beach Invasive Plant Management Plan

Town of Shelter Island

Project Specifications

Annual Maintenance and Follow-up Herbicide Applications

Several of the target plant species (especially black locust, Russian olive, and Asiatic bittersweet) may re-sprout after the initial herbicide application through root suckering. Other invasive species, such as multiflora rose, produce large quantities of seeds and may re-germinate from seeds in the soil. Lastly, some herbaceous invasive species, such as mugwort and Phragmites, may attempt to colonize the areas cleared of invasive trees and shrubs. Therefore, annual monitoring of management areas is necessary to identify re-growth shoots and any new invasive plants for maintenance weeding or herbicide application. Re-growth shoots and newly germinating plants shall be controlled using a foliar herbicide application due to the small size of re-growth shoots.

Annual monitoring should be conducted in the months of June-July to allow for any necessary follow-up herbicides (applied between August 1 and September 30).
Annual monitoring shall be conducted by a qualified ecologist or botanist.
The aim of annual monitoring is to find any persistent or new stands of invasive plants, so that these plants can be treated or eliminated. Any observed invasive plants should be labeled with flagging tape or equivalent to allow follow-up herbicide or weeding staff to locate invasive plants.
Annual monitoring shall be conducted for three growing seasons after the initial cutting and herbicide application

Follow-up Herbicide Applications
Foliar herbicides shall be applied to any stands of target invasive plants identified by the project biologist. Herbicides shall consist of 1-2% glyphosate solution (v/v) in water with 0.5% non-ionic surfactant (Accord or Rodeo).
Foliar herbicides shall be applied between August 1 and September 30.
Herbicides shall not be applied directly or indirectly to native vegetation.
No herbicides shall be used in tidal wetland areas.

No herbicides may be applied if air temperature is more than 50 ºF, no rain is predicted for the next 24 hours, and when wind speeds are less than 8 mph.
Herbicides shall be applied with a backpack sprayer or wick stick.
Leaves and green stems shall be thoroughly wet, but not to the point of runoff.
Herbicide solutions shall be mixed on the existing roadway and not in areas of vegetation or the open beach.
Herbicides shall be applied by a New York State certified herbicide applicator.
The Herbicide shall be applied in accordance with the manufacturer's instructions and the NYSDEC regulations.

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Project Specifications

Bare Root Culm/Herbaceous Plug Planting Specifications:

Native Planting Area

Native Planting Area	Area (Sq. Ft.)	Plant Quantity	Species Composition
Eastern Planting Area	3,581	1,591	1,050 Ammophila plugs (or 2,100 bare root culms), 541 Solidago and/or Lathyrus plugs
Central Planting Area	5,311	2,360	1,558 Ammophila plugs (or 3,116 bare root culms), 802 Solidago and/or Lathyrus plugs
Western Planting Area	2,969	1,319	1,319 Ammophila (or 2,638 bare root culms)

Plugs/culms shall be installed on the exposed/eroded dune face, in any observed bare areas above the top of the slope face, and in a 5 ft wide band seaward from the toe of the slope.
Two bare root culms shall be planted per planting hole on 18 inch centers. One herbaceous 2 inch plugs shall be planted per planting hole on 18 inch centers.
Ammophila bare root culms must be installed between March 1 and April 1. Plugs must be installed between April 1 and May 15. This early planting for plugs is necessary to avoid or minimize irrigation requirements during the summer months.
Delivered plugs should have labels/tags indicating botanical name, common name, and nursery.
85% of the planted vegetation is required after the end of two growing seasons. Contractor shall be responsible for replanting once during the appropriate planting season to achieve a minimum of 85 percent of the planted quantity.
Plant should have well developed root systems and shall be free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement, and abrasion. Plants shall be free of shock or damage to branches, trunks or root systems.
Roots should be sufficiently well-developed for the root mass to retain its shape and hold together when removed from the trays or containers.
Plants shall be furnished in sizes indicated. Acceptable plants shall be well-shaped, full, and symmetrical plants of uniform color and texture.
Inorganic fertilizer shall be applied in each planting hole for herbaceous plugs.
Fertilizer shall be controlled release commercial grade, free flowing, uniform in composition, and consist of a 8-6-12 nitrogen-phosphorus-potassium ratio. 2.5 oz of fertilizer shall be placed in each planting hole for bare root culms or plugs. The fertilizer shall be derived from sulphur coated urea, urea formaldehyde, plastic or polymer coated pills or isobutylenediurea. Fertilizer shall be balanced with the inclusion of trace minerals and micro-nutrients.
Plants not installed on the day of arrival at the Project Site shall be stored and protected in designated areas from direct exposure to wind and sun. Plants must not be stored on-site for more than 7 days before planting.
Bare root culms not installed on the day of arrival shall be heeled into the sand at an upland location to avoid dessication of culms.
Plugs not installed on the day of arrival shall be watered (with freshwater) to keep roots moist.
For bare root culms and herbaceous plugs, fertilizer shall be placed in the bottom of each planting hole prior to placing a plug.
Bare root culms at least 8 inches deep. Plants shall be set plumb, with the root system oriented downward, and held in position until sufficient soil has been firmly placed by hand around the culm. It shall be unacceptable to step on or around planting holes for the purposed of placing backfill.
Plugs shall be planted at a depth of no more than 1 inch deeper than grown in the nursery. The top of the rootstock mass shall be a minimum of 1 inch below the soil surface. Plants shall be set plumb, with the root system oriented downward, and held in position until sufficient soil has been firmly placed by hand around the root mass. The plant shall be set even with or slightly higher than the surrounding grade. It shall be unacceptable to step on or around planting holes for the purposed of placing backfill.

Land Use Ecological Services, Inc.

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Drawn By: W. Bowman
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For: Suffolk County Peconic Estuary Program
Conceptual Habitat Restoration Project
Scale: NTS
Revisions:

APPENDIX A:

Plant Inventory of Shell Beach

Common Name	Scientific Name
American Beach Grass	*Ammophila brevigulata*
Seaside Goldenrod	*Solidago sempervirens*
Beach Rocket	*Cakile edentula*
Beach Pea	*Lathyrus japonicus*
Narrow-leaved Plantain	*Plantago lanceolata*
Common Hawkweed	*Hieracium vulgatum*
Red Sorrel	*Rumex acetosella*
Sickle-leaved Golden Aster	*Chrysopsis falcata*
White Campion	*Silene alba*
Downy Brome	*Bromus tectorum*
Morrow's Honeysuckle	*Lonicera morrowii*
Yellow Rocket	*Barbarea vulgaris*
Sheep Fescue	*Festuca ovina*
Varrow	*Achillea millefolium*
Daisy Fleabane	*Erigeron strigosus*
Spearmint	*Mentha spicata*
Cleavers	*Galium aparine*
Curled Dock	*Rumex crispus*
Narrow-leaved Vetch	*Vetcha angustifolia*
Sweet Clover	*Melilotus alba*
Witch Grass	*Panicum capillare*
Wild Peppergrass	*Lepidium virginicum*
Henbit	*Lamium amplexicaule*
Thyme-leaved Sandwart	*Arenaria serpyllifolia*
Black Locust	*Robinia pseudoacacia*
Japanese Black Pine	*Pinus thunbergii*
Mimosa	*Mimosa pigra*
Tree of Heaven	*Ailanthus altissima*
Russian Olive	*Elaeagnus angustifolia*

Common Name	Scientific Name
Autumn Olive	*Elaeagnus umbellata*
Black Cherry	*Prunus serotina*
Red Oak	*Quercus rubra*
Blackjack Oak	*Quercus marilandica*
Bayberry	*Myrica pensylvanica*
Beach Plum	*Prunus maritima*
Prickly Dewberry	*Rubus flagellaris*
Poison Ivy	*Toxicodendron radicans*
Prickly Pear	*Opuntia humifusa*
Reindeer Lichen	*Cladonia rangiferina*
Evening Primrose	*Oenothera spp.*
Wild Carrot	*Daucus carota*
Jointweed	*Polygonella articulata*
Mayweed	*Matricaria*
Pineapple Weed	*Matricaria discoidea*
Goose Grass	*Galium aparine*
Fall Panicum	*Panicum dichotomiflorum*
Switch Grass	*Panicum virgatum*
Bitter panicgrass	*Panicum amurum*
Smooth Cordgrass	*Spartina alterniflora*
Saltmeadow Cordgrass	*Spartina patens*
Saltgrass	*Distichlis spicata*
Sea Lavender	*Limonium*
American Glasswort, Pickleweed	*Salicornia virginica*
Phragmites	*Phragmites australis*
Black Grass	*Juncus gerardii*
Groundsel Bush	*Baccharis halimifolia*
Rugosa Rose	*Rosa rugosa*
Multiflora Rose	*Rosa multiflora*
Asiatic Bittersweet	*Celastrus orbiculatus*

APPENDIX B: Site Photographs

Shell Beach Invasive Plant Management Plan

Town of Shelter Island

Photo A: Native Maritime Grassland Community at Shell Beach

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Shell Beach Invasive Plant Management Plan

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Photo B: Black Locust Dominated Woodland at eastern end of Shell Beach

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Photo C: Black Locust Dominated Woodland at eastern end of Shell Beach

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Photo D: Asiatic Bittersweet climbing in Black Locust Stand

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Photo E: Tree of Heaven Saplings in Understory of Locust Stand

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Shell Beach Invasive Plant Management Plan

Town of Shelter Island

Photo F: Phragmites Shoots in Understory of Locust Stand

Land Use Ecological Services, Inc.	Prepared By: Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763 Drawn By: W. Bowman Date: 12/21/2012	Project: Shell Beach Invasive Plant Management Plan For: Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project Scale: NTS Revisions:

Shell Beach Invasive Plant Management Plan

Town of Shelter Island

Photo G: Prickly Pear in Understory of Locust Stand

Prepared By: Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763 Drawn By: W. Bowman Date: 12/21/2012	Project: Shell Beach Invasive Plant Management Plan For: Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project Scale: NTS Revisions:

Shell Beach Invasive Plant Management Plan

Town of Shelter Island

Photo H: Bayberry Shrubs Adjacent to Japanese Black Pine

Prepared By: Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763 Drawn By: W. Bowman Date: 12/21/2012	Project: Shell Beach Invasive Plant Management Plan For: Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project Scale: NTS Revisions:

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Photo I: Black Locust on Slope Between Oak Tree Lane and Beach

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Shell Beach Invasive Plant Management Plan

Town of Shelter Island

Photo J: Invasive Trees on Slope Between Oak Tree Lane and Beach at Western End of Shell Beach

Land Use Ecological Services, Inc.	Prepared By: Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763 Drawn By: W. Bowman Date: 12/21/2012	Project: Shell Beach Invasive Plant Management Plan For: Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project Scale: NTS Revisions:

Shell Beach Invasive Plant Management Plan

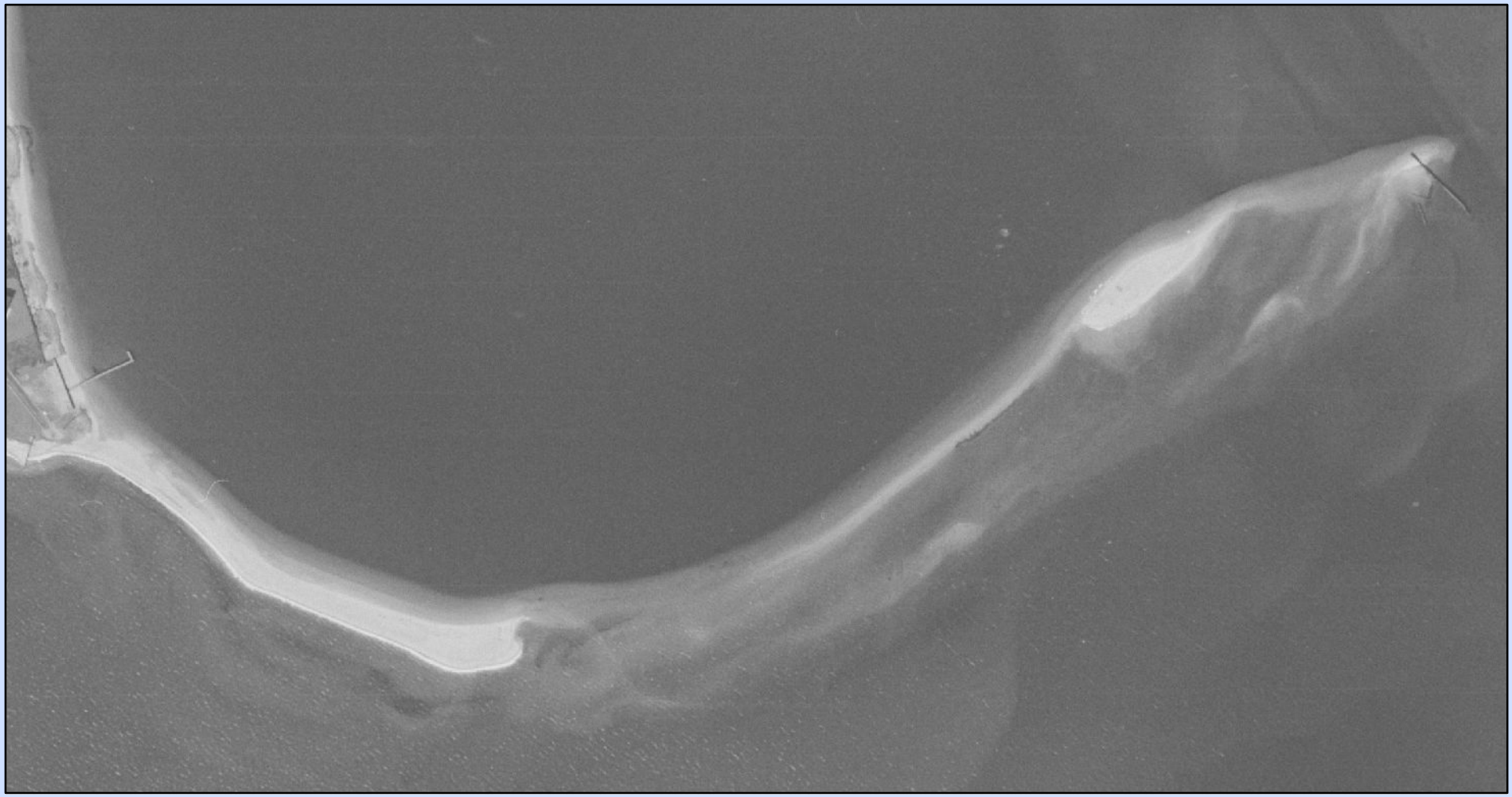
Town of Shelter Island

Photo K: Multiflora Rose and Asiatic Bittersweet on Slope Between Oak Tree Lane and Beach

Prepared By: Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763 Drawn By: W. Bowman Date: 12/21/2012		Project: Shell Beach Invasive Plant Management Plan For: Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project Scale: NTS Revisions:

Figure 1. 1954 Aerial Photograph

Shell Beach, Shelter Island



NOTES:

1. Date of Photography: 3/1/1954
2. Data Source: USGS (Earth Explorer)

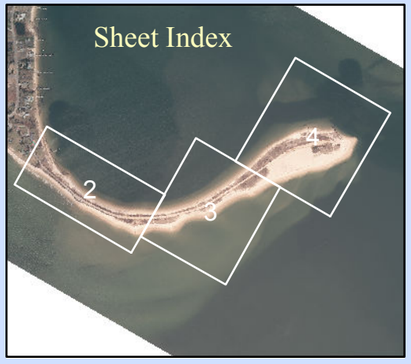
Prepared By:	Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763	Project:	Shell Beach Invasive Plant Management Plan
		For:	Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project
Drawn By:	K. Risotto	Scale:	NTS
Date:	12/21/2012	Revisions:	

Shell Beach Invasive Plant Management Plan

Town of Shelter Island

NOTES:

1. Tidal Wetland Boundary delineated by W.P. Bowman, Land Use Ecological Services, Inc. on May 19, 2012.
2. Base Map: 2010 Orthoimage (NYSOCS).
3. Coordinate System: NAD 1983 UTM Zone 18N (equivalent to Long Island State Plane coordinate system).



- Tidal Wetland Boundary
- Temporary Symbolic Fencing During Construction
- High Density Invasive Woody Tree/Shrub Control Area
- Low Density Invasive Woody Tree/Shrub Control Area
- Native Plant Restoration Area
- Sensitive Plant and Lichen Protection Area
- Topsoil Removal from Existing Gabion Wall
- Protected Shorebird Nesting Area

Sheet 1: Overall Plan

Prepared By:	Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763	Project:	Shell Beach Invasive Plant Management Plan
Drawn By:	K. Risotto	For:	Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project
Date:	12/20/2012	Scale:	As Noted
		Revisions:	

Shell Beach Invasive Plant Management Plan

Town of Shelter Island

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N

1 inch = 150 feet

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Shell Beach Invasive Plant Management Plan

Town of Shelter Island

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2. Base Map: 2010 Orthoimage (NYSOCS).
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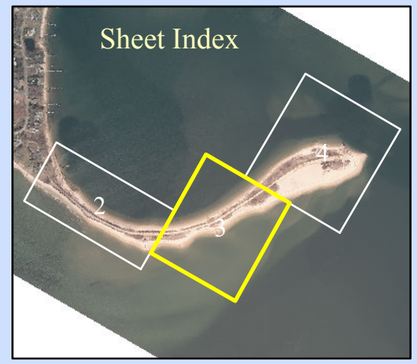

N

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Sheet 3

Prepared By:	Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763	Project:	Shell Beach Invasive Plant Management Plan
Drawn By:	K. Risotto	For:	Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project
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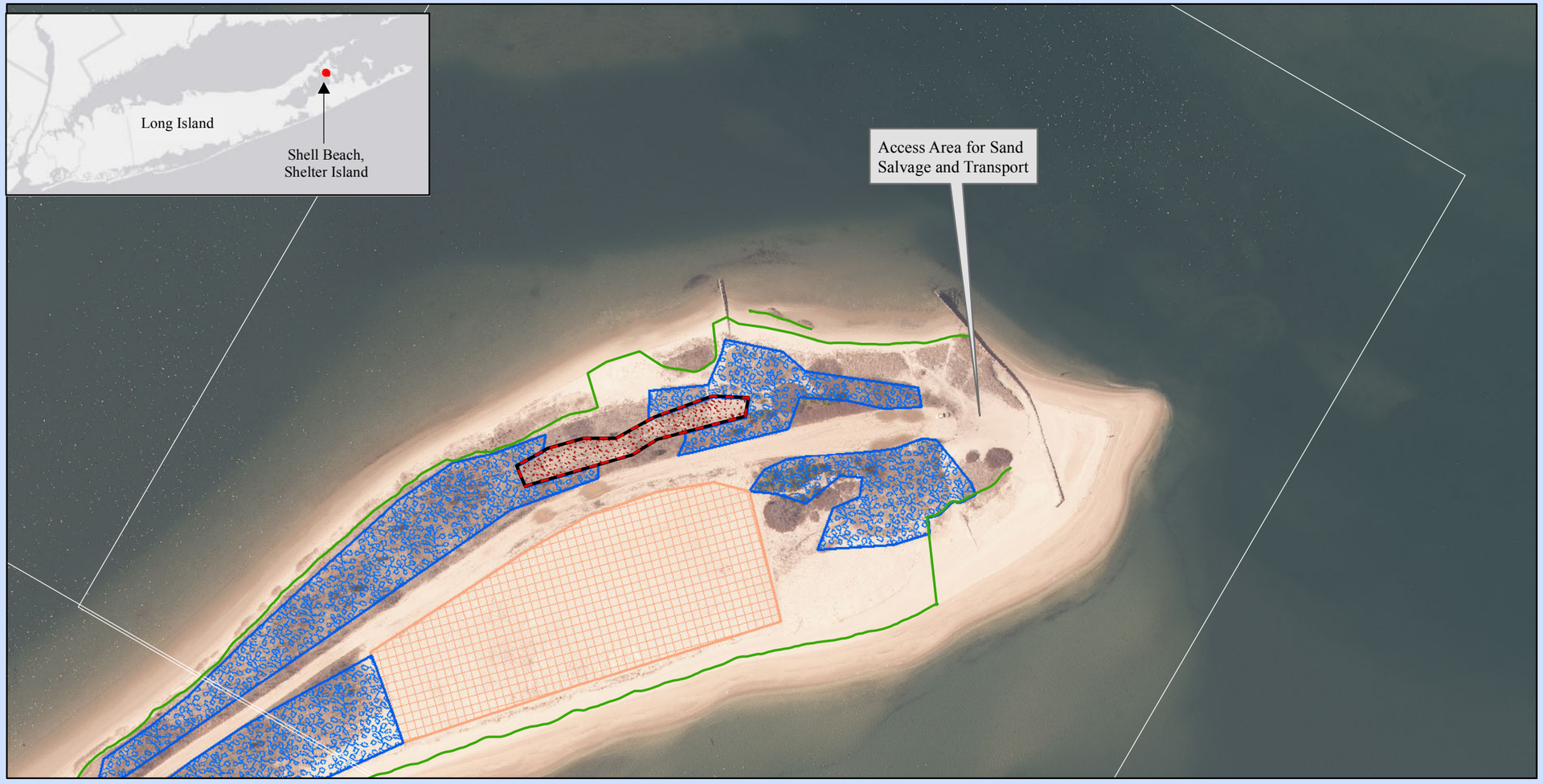
Shell Beach Invasive Plant Management Plan

Town of Shelter Island



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2. Base Map: 2010 Orthoimage (NYSOCS).
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Sheet 4

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Drawn By:	K. Risotto	For:	Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project
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Shell Beach Invasive Plant Management Plan

Town of Shelter Island

Project Specifications

Herbicide Application:

Invasive trees and shrubs shall controlled in the following manner in both *High Density* and *Low Density* Management Areas. No herbicides shall be applied in the plant protection area.

Trees and shrubs of the following species shall be cut as close to ground level as possible (18" minimum):

Black Locust (*Robinia pseduoacacia*) Japanese Black Pine (*Pinus thunbergii*) Autumn Olive (*Elaeagnus umbellata*) Multiflora Rose (*Rosa multiflora)*
Tree of Heaven (*Ailanthus altissima*) Asiatic Bittersweet (*Celastrus orbiculatus*) Shrub Honeysuckle (*Lonicera sp.*)

All cut biomass shall be removed from the project site. For methods regarding the removal of woody biomass refer to the following *Cutting and Removal Methods* section.
Cutting and herbicide application shall occur between August 1 and September 30 to minimize the potential for disturbance to non-target plant species during cutting and removal or herbicide application.
Initial herbicide applications shall be "cut stump" application of 20-30% triclopyr solution (Garlon4 Ultra) in basal oil.
Herbicides shall not be applied to native vegetation.
No herbicides shall be used in tidal wetland areas.
In cases where an invasive vine (such as Asiatic bittersweet) is growing on an invasive tree, both the tree and vine should be cut to ground level and herbicides applied to the cut stumps.
Herbicide solutions shall be mixed on the existing roadway and not in areas of vegetation or the open beach.
Herbicides shall be applied by a New York State certified herbicide applicator.
Herbicide application to cut stump should occur immediately after cutting (within 1 hour) to ensure maximum uptake of the herbicide.
Herbicide shall be applied using a wickstick, sponge-type applicator, paintbrush, ore equivalent.
The Herbicide shall be applied in accordance with the manufacturer's instructions and the NYSDEC regulations.
Herbicide should not be applied if air temperature is less than 50ºF or rain is expected within the next 24 hours. No wind speed restrictions (typically 8 mph) are necessary as herbicides shall be applied to cut stumps directly without a sprayer. If a sprayer, is utilized for follow-up herbicide treatments, herbicides shall not be applied if wind speed exceeds 8 mph.
The cut stump and bark below the cut shall be thoroughly wetted down to the root collar. However, no runoff from the stump's bark or incidental application of the herbicide to ground or nearby vegetation is authorized.

Cutting and Removal

Invasive trees shall be cut to ground level with motorized hand tools (i.e. chain saw, long-handled pruner, or handsaws). All cutting and stockpiling of cut biomass shall be conducted in a manner to avoid disturbance to native vegetation.
Due to the fairly large size of some of the targeted trees, appropriate arboricultural practices and safety equipment shall be employed to minimize risk of injury to workers.
To avoid disturbance to native vegetation, no vehicles or small heavy equipment (i.e. skidsteer) are permitted within the restoration areas.
All cut trunks, stems, and branches shall be removed from the management areas by hand. Cut biomass shall be carried by hand to the road or the beach, where biomass can be loaded into vehicles for removal.
A qualified ecologist or botanist shall supervise the cutting and removal of invasive trees and shrubs to minimize disturbance to native vegetation.
All cut biomass shall be disposed of at a licensed upland disposal or recycling facility.

Land Use Ecological Services, Inc.	Prepared By: Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763 Drawn By: W. Bowman Date: 12/21/2012
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Shell Beach Invasive Plant Management Plan

Town of Shelter Island

Project Specifications

Annual Maintenance and Follow-up Herbicide Applications

Several of the target plant species (especially black locust, Russian olive, and Asiatic bittersweet) may re-sprout after the initial herbicide application through root suckering. Other invasive species, such as multiflora rose, produce large quantities of seeds and may re-germinate from seeds in the soil. Lastly, some herbaceous invasive species, such as mugwort and Phragmites, may attempt to colonize the areas cleared of invasive trees and shrubs. Therefore, annual monitoring of management areas is necessary to identify re-growth shoots and any new invasive plants for maintenance weeding or herbicide application. Re-growth shoots and newly germinating plants shall be controlled using a foliar herbicide application due to the small size of re-growth shoots.

Annual monitoring should be conducted in the months of June-July to allow for any necessary follow-up herbicides (applied between August 1 and September 30).
Annual monitoring shall be conducted by a qualified ecologist or botanist.
The aim of annual monitoring is to find any persistent or new stands of invasive plants, so that these plants can be treated or eliminated. Any observed invasive plants should be labeled with flagging tape or equivalent to allow follow-up herbicide or weeding staff to locate invasive plants.
Annual monitoring shall be conducted for three growing seasons after the initial cutting and herbicide application

Follow-up Herbicide Applications
Foliar herbicides shall be applied to any stands of target invasive plants identified by the project biologist. Herbicides shall consist of 1-2% glyphosate solution (v/v) in water with 0.5% non-ionic surfactant (Accord or Rodeo).
Foliar herbicides shall be applied between August 1 and September 30.
Herbicides shall not be applied directly or indirectly to native vegetation.
No herbicides shall be used in tidal wetland areas.

No herbicides may be applied if air temperature is more than 50 ºF, no rain is predicted for the next 24 hours, and when wind speeds are less than 8 mph.
Herbicides shall be applied with a backpack sprayer or wick stick.
Leaves and green stems shall be thoroughly wet, but not to the point of runoff.
Herbicide solutions shall be mixed on the existing roadway and not in areas of vegetation or the open beach.
Herbicides shall be applied by a New York State certified herbicide applicator.
The Herbicide shall be applied in accordance with the manufacturer's instructions and the NYSDEC regulations.

Land Use Ecological Services, Inc.

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570 Expressway Drive South, Suite 2F
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Drawn By: W. Bowman
Date: 12/21/2012

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For: Suffolk County Peconic Estuary Program
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Revisions:

Shell Beach Invasive Plant Management Plan

Town of Shelter Island

Project Specifications

Bare Root Culm/Herbaceous Plug Planting Specifications:

Native Planting Area

Native Planting Area	Area (Sq. Ft.)	Plant Quantity	Species Composition
Eastern Planting Area	3,581	1,591	1,050 Ammophila plugs (or 2,100 bare root culms), 541 Solidago and/or Lathyrus plugs
Central Planting Area	5,311	2,360	1,558 Ammophila plugs (or 3,116 bare root culms), 802 Solidago and/or Lathyrus plugs
Western Planting Area	2,969	1,319	1,319 Ammophila (or 2,638 bare root culms)

Plugs/culms shall be installed on the exposed/eroded dune face, in any observed bare areas above the top of the slope face, and in a 5 ft wide band seaward from the toe of the slope.
Two bare root culms shall be planted per planting hole on 18 inch centers. One herbaceous 2 inch plugs shall be planted per planting hole on 18 inch centers.
Ammophila bare root culms must be installed between March 1 and April 1. Plugs must be installed between April 1 and May 15. This early planting for plugs is necessary to avoid or minimize irrigation requirements during the summer months.
Delivered plugs should have labels/tags indicating botanical name, common name, and nursery.
85% of the planted vegetation is required after the end of two growing seasons. Contractor shall be responsible for replanting once during the appropriate planting season to achieve a minimum of 85 percent of the planted quantity.
Plant should have well developed root systems and shall be free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement, and abrasion. Plants shall be free of shock or damage to branches, trunks or root systems.
Roots should be sufficiently well-developed for the root mass to retain its shape and hold together when removed from the trays or containers.
Plants shall be furnished in sizes indicated. Acceptable plants shall be well-shaped, full, and symmetrical plants of uniform color and texture.
Inorganic fertilizer shall be applied in each planting hole for herbaceous plugs.
Fertilizer shall be controlled release commercial grade, free flowing, uniform in composition, and consist of a 8-6-12 nitrogen-phosphorus-potassium ratio. 2.5 oz of fertilizer shall be placed in each planting hole for bare root culms or plugs. The fertilizer shall be derived from sulphur coated urea, urea formaldehyde, plastic or polymer coated pills or isobutylenediurea. Fertilizer shall be balanced with the inclusion of trace minerals and micro-nutrients.
Plants not installed on the day of arrival at the Project Site shall be stored and protected in designated areas from direct exposure to wind and sun. Plants must not be stored on-site for more than 7 days before planting.
Bare root culms not installed on the day of arrival shall be heeled into the sand at an upland location to avoid dessication of culms.
Plugs not installed on the day of arrival shall be watered (with freshwater) to keep roots moist.
For bare root culms and herbaceous plugs, fertilizer shall be placed in the bottom of each planting hole prior to placing a plug.
Bare root culms at least 8 inches deep. Plants shall be set plumb, with the root system oriented downward, and held in position until sufficient soil has been firmly placed by hand around the culm. It shall be unacceptable to step on or around planting holes for the purposed of placing backfill.
Plugs shall be planted at a depth of no more than 1 inch deeper than grown in the nursery. The top of the rootstock mass shall be a minimum of 1 inch below the soil surface. Plants shall be set plumb, with the root system oriented downward, and held in position until sufficient soil has been firmly placed by hand around the root mass. The plant shall be set even with or slightly higher than the surrounding grade. It shall be unacceptable to step on or around planting holes for the purposed of placing backfill.

Land Use Ecological Services, Inc.

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Drawn By: W. Bowman
Date: 12/21/2012

Project: Shell Beach Invasive Plant Management Plan
For: Suffolk County Peconic Estuary Program
Conceptual Habitat Restoration Project
Scale: NTS
Revisions:

APPENDIX C: Shell Beach Strategic Ecological Restoration Plan

Shell Beach Strategic Ecological Restoration Plan

The purpose of this plan is to provide a framework for restoration of Shell Beach due to the impacts associated with the Shell Beach groin and revetment project. The shoreline protection project will prevent natural processes from forming and shaping the natural habitats typically associated with sand spits in the coastal marine environment. This plan will be coordinated fully with the U.S. Fish and Wildlife Service and other regulatory agencies, as needed.

Due to past shoreline stabilization efforts on Shell Beach and what are deemed to be the likely adverse affects of the currently proposed project(s), there have been changes to the native vegetation on Shell Beach. For example, due to the curtailment of natural processes which create and maintain natural sand spit features, invasive or introduced species, including but not limited to, tree of heaven (*Ailanthus altissima*), black locust (*Robinia pseudoacacia*), Japanese black pine (*Pinus thunbergii*), and Russian olive (*Elaeagnus angustifolia*) now occur on the sand spit. It is also possible that some of these species were purposely planted on the sand spit as a means of erosion control and dune stabilization. Invasive plants are introduced species that can thrive in areas beyond their natural range of dispersal. These plants are characteristically adaptable, aggressive, and have a high reproductive capacity. Their vigor combined with a lack of natural enemies often leads to outbreak populations http://www.invasivespeciesinfo.gov/plants/main.shtml). These species provide perching and nesting habitat for a number of species which can prey upon the Federally-listed piping plover (*Charadrius melodus*) which breeds on Shell Beach. For example, increased depredation by crows may be an indirect adverse impact of woody vegetation plantings. Elias-Gerken (1994) observed these avian predators perching and nesting in exotic Japanese black pines along the Ocean Parkway on Jones Island, New York and hypothesized that this vegetation and other artificial perches exacerbated depredation by crows there (U.S. Fish and Wildlife Service 1996).

Removal of Invasive and Exotic Species

In order to protect the piping plover which breeds at this site as well as any migratory birds that potentially utilize these invasive plant species for nesting, all restoration activities will occur between September 1 and March 31.

This project will commence in stages, with the first stage planned for late 2008 and early 2009 (Jan – March 31) in the area outlined in green on the project map which focuses on the piping plover breeding area located closest to the tip of the spit. In this area, invasive species will be controlled[1] utilizing the most effective and appropriate techniques, such as girdling, cutting, hand pulling and possibly herbicide treatment during follow-up control efforts (*e.g.*, to prevent re-germination). The Town will undertake these measures for at

[1] 'Control' means, as appropriate, eradicating, suppressing, reducing, or managing invasive species populations, preventing spread of invasive species from areas where they are present, and taking steps such as restoration of native species and habitats to reduce the effects of invasive species and to prevent further invasions (http://www.invasivespeciesinfo.gov/laws/execorder.shtml#sec1)

least five years or until such time as these species have been controlled. Subsequent phases of the project will commence during the same seasonal window for the years 2009 and early 2010, unless the restoration can be completed in a more timely manner.

In the stockpile area and in the groin and revetment zones, the Town will ensure that native grass, shrub and tree species are used to revegetate any of the disturbed areas associated with these projects. A general list of appropriate species is provided below (from Edinger *et al*, 2002).

> **Maritime dunes:** a community dominated by grasses and low shrubs that occurs on active and stabilized dunes along the Atlantic coast. This community consists of a mosaic of vegetation patches. This mosaic reflects past disturbances such as sand
> deposition, erosion, and dune migration. The composition and structure of the vegetation is variable depending on stability of the dunes, amounts of sand deposition and erosion, and distance from the ocean.
>
> Characteristic species of the active dunes, where sand movement is greastest, include: beachgrass (*Ammophila breviligulata*),
> dusty-miller (*Artemisia stelleriana*),
> beach pea (*Lathyrus japonicus*),
> sedge (*Carex silicea*),
> seaside goldenrod (*Solidago sempervirens*),
> sand-rose (*Rosa rugosa*).
>
> Characteristic species of stabilized dunes include:
> beach heather (*Hudsonia tomentosa*),
> bearberry (*Arctostaphylos uva-ursi*),
> beachgrass (*Ammophila breviligulata*),
> cyperus (*Cyperus polystachyos* var. *macrostachyus*),
> seaside goldenrod (*Solidago sempervirens*),
> beach pinweed (*Lechea maritima*),
> jointweed (*Polygonella articulata*),
> sand-rose (*Rosa rugosa*),
> bayberry (*Myrica pensylvanica*),
> beach-plum (*Prunus maritima*),
> poison ivy (*Toxicodendron radicans*),
> and the lichens *Cladina submitis* and *Cetraria arenaria*).
>
> A few stunted pitch pines (*Pinus rigida*) or post oaks (*Quercus stellata*) may be present in the dunes.

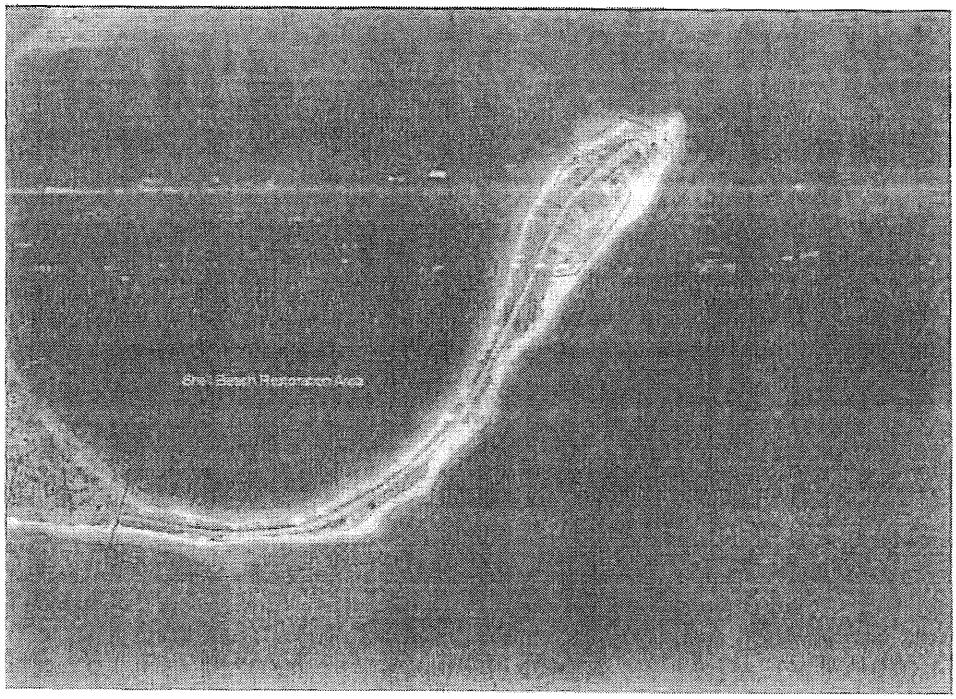
The density at which these plants are utilized will be coordinated fully with the U.S. Fish and Wildlife Service during a future on-site meeting, particularly in the areas which support endangered species. The Town will ensure that the targeted density is maintained

over time to ensure that piping plover breeding habitats remain suitable and do not become over vegetated.

Other Restoration Initiatives on Shell Beach

The control of invasive species will be accomplished under this plan in association with efforts to continue public education and outreach about coastal environments and endangered species protection as well as measures to monitor and manage avian and mammalian predators which are on Shell Beach. As the control of such species is under the under the jurisdiction of the U.S. Fish and Wildlife Service and New York State Department of Environmental Conservation, the Town will coordinate with these agencies this year to begin developing a plan under the auspices of this larger restoration effort to address these species and their impacts on threatened and endangered species at this site.

Shell Beach, Shelter Island, New York



Overall Restoration Area
Phase 1 Site

References

Elias-Gerken, S.P. and J.D. Fraser. 1994. Piping plover foraging ecology on Pike's Beach, Southampton, New York. Final report submitted to the U.S. Fish and Wildlife Service, Sudbury, Massachusetts. 61 pp.

U.S. Fish and Wildlife Service. 1996. Piping Plover *(Charadrius melodus)*, Atlantic Coast Population, Revised Recovery Plan. Hadley, Massachusetts. 258 pp.

Edinger, G.J., D.J. Evans, S. Gebauer, T.G. Howard, D.M. Hunt, and A.M. Olivero (editors). 2002. Ecological Communities of New York State. Second Edition. A revised and expanded edition of Carol Reschke's *Ecological Communities of New York State.* (Draft for review). New York Natural Heritage Program, New York Department of Environmental Conservation, Albany, NY.

APPENDIX D:

Hurricane Sandy resulted in significant coastal erosion and flooding on Shell Beach. Storm surge flooded much of the sand spit with the exception of Oak Tree Lane and its berm. Oak Tree Lane was overtopped at the western end allowing flood waters to flow directly from Shelter Island Sound to West Neck Harbor. Based on a topographical survey of Shell Beach prepared by Cashin Associates (dated 02/2012), it appears that the Hurricane Sandy storm surge reached an elevation of approximately 8 feet NAVD 1988. In response to the erosion damage caused by Hurricane Sandy, the Town of Shelter Island placed clean sand fill on the eroded scarps and slopes at Shell Beach under the NYSDEC Hurricane Sandy General Permit (GP-0-12-006) in February 2013. Sand fill was placed in 0.7 acres of Shell Beach on both the north and south sides of Oak Tree Lane (Photos 1-4). The recommended plant species and spacing for these areas are described below and in Section 3.2 (Native Plant Restoration Areas).

- American Beach Grass (*Ammophila breviligulata*)- 2" plugs or bare root culms on 18" centers
- Seaside Goldenrod (*Solidago sempervirens*)- 2" plugs on 18" centers
- Beach Pea (*Lathyrus japonica*)- 2" plugs on 18" centers

On the northern side of Oak Tree Lane, it would be appropriate to include other plant species such as switchgrass (*Panicum virgatum*), bitter panicgrass (*Panicum amarum*), or little bluestem (*Schizachyrium scoparium*) in the planting list. These species would also be appropriate for planting on the upper slopes and top of the sand on the southern side of Oak Tree Lane. However, installation of herbaceous plugs of these warm season grasses would require the planting areas to be regularly irrigated throughout the growing season. Successful establishment of herbaceous plugs typically requires providing 1 inch of water weekly through a combination of natural precipitation and irrigation. Due to the remote location of Shell Beach, regular irrigation of herbaceous warm season grass plugs would be challenging. Accordingly, it has been recommended that American beach grass bare root culms be installed to minimize the irrigation requirements for re-vegetation of these new sand placement areas.

Re-vegetation of the 0.7 acres of placed sand would require the quantities of plant material provided below.

Table D1: Plant Quantities for Hurricane Sandy Sand Placement Areas

Native Planting Area	*Area (Sq. Ft.)*	*Plant Quantity*	*Species Composition*
Hurricane Sandy Sand Placement Areas	29,989	13,195	9,232 Ammophila plugs (or 18,464 bare root culms), 4,616 Solidago and/or Lathyrus plugs

Estimated planting costs for re-vegetating these new sand placement areas are provided below.

Table D2: Estimated Native Planting Costs

Item	*Cost*
Plant Material	$780-$1,080
Labor	$3,600-$6,000
Total	$8,303-$15,090

Shell Beach Post-Sandy Native Planting Plan

Town of Shelter Island

Photo A: Post-Hurricane Sandy Sand Placement Area at Shell Beach

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Shell Beach Post-Sandy Native Planting Plan

Town of Shelter Island

Photo B: Post-Hurricane Sandy Sand Placement Area at Shell Beach

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Shell Beach Post-Sandy Native Planting Plan

Town of Shelter Island

Photo C: Post-Hurricane Sandy Sand Placement Area at Shell Beach

Prepared By: Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763 Drawn By: W. Bowman Date: 12/21/2012	Project: Shell Beach Invasive Plant Management Plan For: Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project Scale: NTS Revisions:

Shell Beach Post-Sandy Native Planting Plan

Town of Shelter Island

Photo D: Post-Hurricane Sandy Sand Placement Area at Shell Beach

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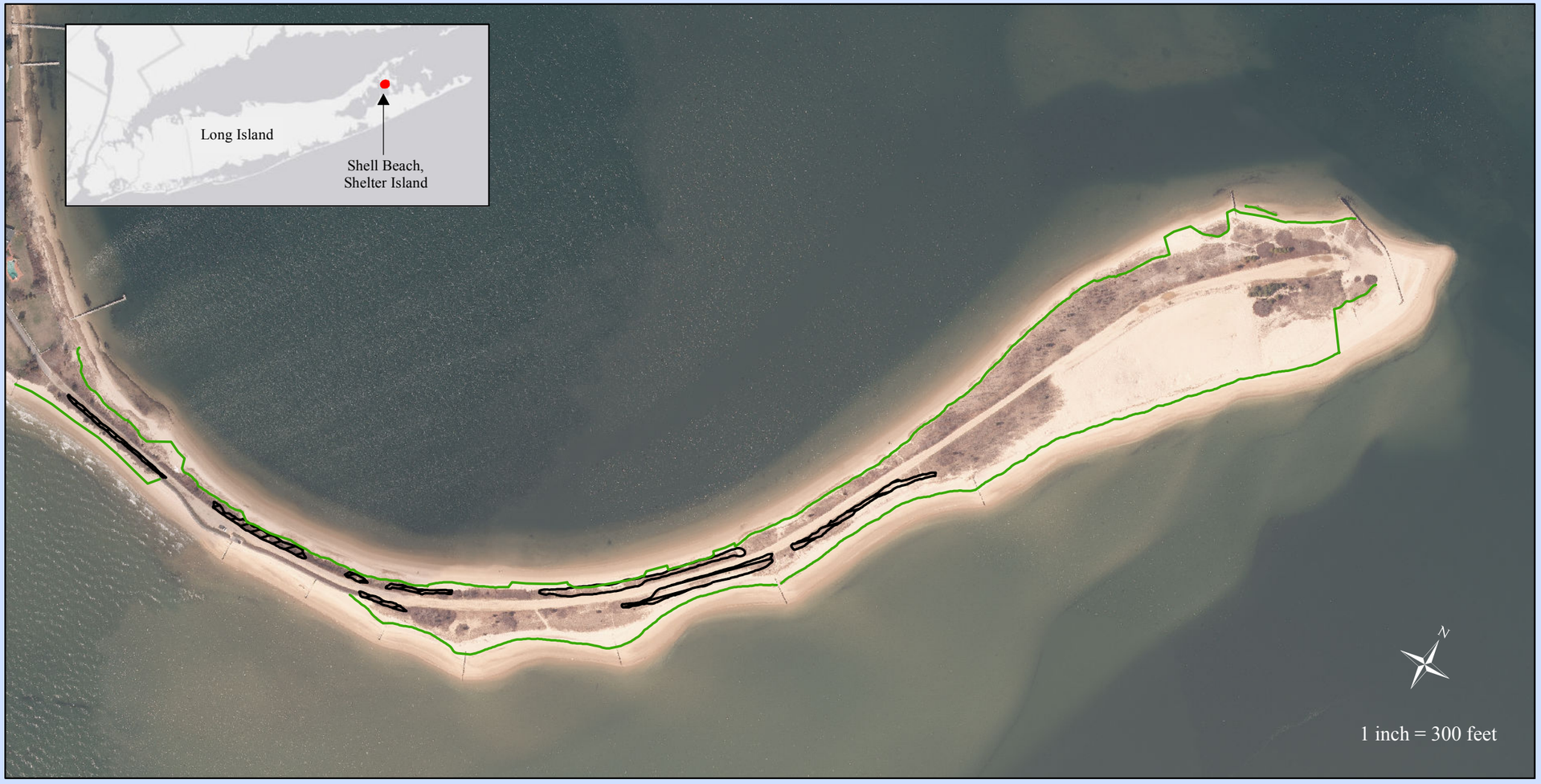
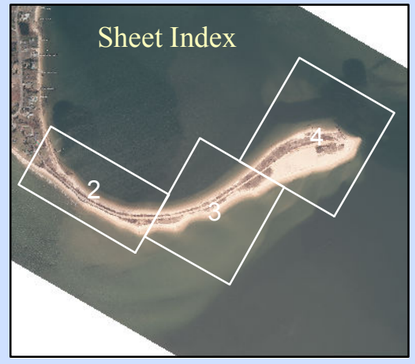


NOTES:

1. Sand placed on eroded scarps and slopes should be planted with native beach and dune vegetation following specifications for Native Plant Restoration Areas.
2. Tidal Wetland Boundary delineated by W.P. Bowman, Land Use Ecological Services, Inc. on May 19, 2012.
3. Base Map: 2010 Orthoimage (NYSOCS).
4. Coordinate System: NAD 1983 UTM Zone 18N (equivalent to Long Island State Plane coordinate system).



Tidal Wetland Boundary

Hurricane Sandy Sand Placement Area

Sheet 1: Overall Plan

Land Use Ecological Services, Inc.	Prepared By:	Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763	Project: Shell Beach Post-Sandy Native Planting Plan For: Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project
	Drawn By:	K. Risotto	Scale: As Noted
	Date:	3/6/2013	Revisions:

Shell Beach Post-Sandy Native Planting Plan

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N

1 inch = 150 feet

Tidal Wetland Boundary

Hurricane Sandy Sand Placement Area

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Drawn By:	K. Risotto	For:	Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project
Date:	3/6/2013	Scale:	As Noted
		Revisions:	

Sheet 2

Shell Beach Post-Sandy Native Planting Plan

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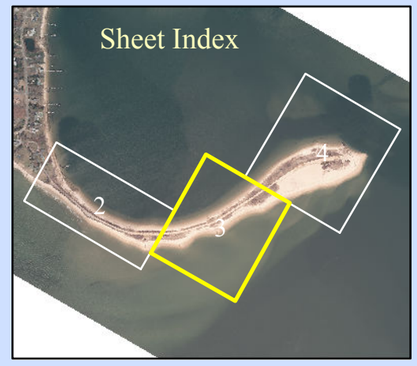

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Tidal Wetland Boundary

Hurricane Sandy Sand Placement Area

Sheet 3

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Drawn By:	K. Risotto	For:	Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project
Date:	3/6/2013	Scale:	As Noted
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Shell Beach Post-Sandy Native Planting Plan

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Tidal Wetland Boundary

Hurricane Sandy Sand Placement Area

Sheet 4

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Date:	3/6/2013	Scale:	As Noted
		Revisions:	