

**DRAFT**



**DUNE VEGETATION MANAGEMENT PLAN  
BOROUGH OF AVALON, CAPE MAY COUNTY, NJ  
DECEMBER 2009**



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## TABLE OF CONTENTS

### Dune Vegetation Management Plan

<u>SECTION</u>	<u>PAGE</u>
SECTION 1. – INTRODUCTION.....	1
SECTION 2 .- BACKGROUND	
2.1 Statement of Values.....	2
2.1.1 Statement of Issues Resulting from the Establishment of Non-native species.....	2
SECTION 3. – DUNE VEGETATION MANAGEMENT PLAN	
3.1 Goals of the Plan.....	2
3.2 Objectives of the Plan.....	3
3.3 Roles and Responsibilities.....	3
3.4 Management Standards.....	4
SECTION 4. - PILOT DEMONSTRATION PROJECT	
4.1 Pilot Demonstration Project.....	7
4.2 Management techniques to be Demonstrated.....	8
SECTION 5. - PLAN APPROVAL PROCESS	
5.1 Review and Approval Process.....	8
5.2 Dune Vegetation Management Plan Implementation.....	9
SECTION 6. CONCLUSION.....	10
SECTION 7. SELECTED REFERENCES.....	11

**SECTION 8. APPENDICES**

<b>APPENDIX A.</b>	<b>Photographs</b>
<b>APPENDIX B.</b>	<b>Preliminary Survey Results - 2008</b>
<b>APPENDIX C.</b>	<b>Communications with NJDEP</b> <ul style="list-style-type: none"><li>• <b>Request for Jurisdictional Determination to NJDEP on August 3, 2009</b></li><li>• <b>Approved Jurisdictional Determination from Andrew Gale of NJDEP on October 1, 2009</b></li></ul>
<b>APPENDIX D.</b>	<b>Memorandum of Understanding between the Borough and Property Owners regarding Vegetation Management in the Avalon Dune System (DRAFT)</b>
<b>APPENDIX E.</b>	<b>Proposed List of Dune Vegetation Comments from Chris Miller, USDA, Plant Material Center (November 4, 2009)</b>
<b>APPENDIX F.</b>	<b>Dune Restoration Plan Strategy Prepared by The Lomax Consulting Group and Illustrated by the Taylor Design Group</b>
<b>APPENDIX G.</b>	<b>Dune Vegetation Management Plan Base Map prepared by The Lomax Consulting Group (Awaiting Delivery of Base Map)</b>
<b>APPENDIX H</b>	<b>Borough of Avalon Dune Ordinance No. 620-2009 and Recommendation of Amendments to Borough's Municipal Recreational Facilities Ordinance (Chapter 9) and Zoning Ordinance (Chapter 27) – Resolution PZ # 09-G and Exhibit A</b>
<b>APPENDIX I</b>	<b>Standard for Creating and Restoring Sand Dunes</b>

## DUNE VEGETATION MANAGEMENT PLAN

### SECTION 1. INTRODUCTION

The dune system of the Borough of Avalon is a critical asset of the community. This dune system:

- (a) Serves the Borough as a protective buffer dissipating coastal storm energy,
- (b) Contains a bank of sand to replenish the beach system,
- (c) Supports a diversity of habitats for adapted plants and wildlife and
- (d) Creates unique aesthetic appeal of the community (**PHOTO 1, 2 AND 3 - APPENDIX A**).

While the dune system is naturally occurring in the Borough, it has required management for more than forty years to retain its integrity and to preserve its unique maritime forest (**PHOTO 4 AND 5 - APPENDIX A**).

Well-meaning dune protection efforts of earlier times have resulted in the introduction of a species that has had unintended consequences, i.e., it has become a dominant feature in the back dune area, displacing native species and demonstrating its invasive nature. The Japanese black pine (*Pinus thunbergiana*) has become so well established in the back dunes adjacent to residences that it has resulted in stands of this pine that have produced associated cone needle-drop. This combustible tinder creates a potential for wildfires in close proximity to the residences (**PHOTO 6 AND 7 - APPENDIX A**). In addition, these stands have created a visual barrier impacting the value of the oceanfront properties (**PHOTO 8 – APPENDIX A**). Finally, these stands of Japanese Black Pine are displacing the diverse native species, thereby creating ecological instability in the dunes. The emerging Japanese black pine monoculture has created a potential vegetative instability because of susceptibility to pests and pathogens. Dead and dying Japanese black pines are readily observable within the stands on the Island, as well as on the mainland. As such, it has become necessary to evaluate the extent of this problem and to establish a strategy to reduce or eliminate the adverse impact of this species while protecting the integrity of the Borough's dune system.

During the summer of 2008, The Lomax Consulting Group evaluated the distribution of the Japanese black pine and reported the survey findings to the Mayor, Environmental Commission and the interested public on August 19, 2008 (Appendix B - Preliminary Survey of the Borough). A Dune Vegetation Management Plan (DVMP or Plan) concept outline was presented and

discussed during the Environmental Committee Meeting on September 16, 2008. Pursuant to guidance from the Environmental Commission, a draft outline was presented for review and direction. During a subsequent meeting with the Borough, the outline was approved and the development of the plan was authorized.

## **SECTION 2. BACKGROUND**

### **2.1 Statement of Values of Dunes and Dune Vegetation**

The Borough of Avalon dune system is a critically important and integral natural resource of the community that provides: (a) a protective buffer dissipating coastal storm energy; (b) a bank of sand to replenish the beach system during coastal storm events; (c) an extensive and diverse habitat for local plants and wildlife adapted to the dune ecosystems and (d) contains and protects the unique maritime forest. Accordingly, the stewardship of the Avalon dunes is, not only recognized as a model for community protection and coastal dune enhancement, but also is critical to the protection of the Borough.

### **2.2 Statement of Issues Resulting from the Establishment of Non-native Species**

Invasive vegetation, such as the Japanese black pine, has spread throughout the back dunes adjacent to residences at such an alarming rate that it has: (a) resulted in hazardous conditions associated with combustible tinder base subject to wildfire in close proximity to residences and the extensive dune system, (b) evolved into monocultures resulting in degraded and unsuitable habitat for wildlife adapted to the native vegetation, (c) subjected portions of the dune system to destabilization through the die back of this species and (d) created an unacceptable barrier impacting the value of the oceanfront properties. Therefore, it has become essential to examine this problem and to establish a strategy to reduce or eliminate the adverse impact of this species, while protecting the integrity of the Borough's dune system.

## **SECTION 3. DUNE VEGETATION MANAGEMENT PLAN**

### **3.1 Goals of the Plan**

- 3.1.1 Maintain a healthy, diverse dune system comprised primarily of native species;
- 3.1.2 Establish a science-based approach to evaluating and managing dune vegetation, in a manner to achieve the goals of the Borough.

### 3.2 Objectives of the Plan

- 3.2.1 To identify problems associated with invasive plant species in the dune system and to define the nature and extent of the related issues;
- 3.2.2 To develop a Dune Vegetation Management Plan that addresses control of invasive plant species;
- 3.2.3 To provide management standards and techniques that allow for the improvement of the vegetative component of the dune ecosystem; and
- 3.2.4 To identify and protect dune vegetation die back areas.

### 3.3 Roles and Responsibilities

- 3.3.1 While the Borough maintains the overall health and integrity of the dune system; appropriate stewardship of the adjoining property owners and visitors is integral to the protection of this community asset. The Borough accomplishes this task by providing the public with proper education and signage that is pertinent to protection of dune features. The Borough has delineated its dune system; those areas defined as dunes are available through the Office of the Construction Official. The Borough has laid out the framework for protecting its ocean-front assets by establishing and implementation of protective ordinances and the enforcement of these rules through its police powers. It should be noted that the Borough went through the process of obtaining a jurisdictional determination from The New Jersey Department of Environmental Protection (NJDEP) to make certain that management techniques set forth herein were in accordance with NJDEP regulations and policies. Please refer to Appendix C for a copy of the jurisdictional request and response documentation. In addition, the Borough supports dune vegetation improvement programs through its Public Works Department and through volunteer beachgrass planting initiatives.
- 3.3.2 Property owners, especially those living adjacent to, or having, dunes on their property play an important role in maintaining a healthy dune system. They have the unique opportunity to protect and to enhance the dune system on or adjacent to their property by planting and managing compatible native vegetation and by aiding the Borough to monitor activities that may damage the dunes. While it is understood that landscaping professionals may be contracted by property owners within the Borough, the ultimate responsibility for actions inconsistent with the Borough ordinances falls on the property owners. Accordingly, various safeguards have been incorporated into the design of the

DVMP. The safeguards provide an opportunity for addressing landowner concerns while providing guidance and public notification through the Dune Vegetation Management planning and implementation process.

- 3.3.3 Land owners and their landscape contractors, who intend to engage in any vegetation management activities in the dune system, must comply with Ordinance 620 – 2009 prior to taking any action. During the application process the Avalon Environmental Commission will review the prepared actions and comment to the Planning / Zoning Board of the Borough. If the proposed action is approved, the landscape contractor will be required to provide notification to the Construction Official of their intention to carry out trimming, thinning or removal of dune vegetation. They will also be required to provide photo documentation of the site conditions before and at the conclusion of the vegetation management process. Monitoring schedules shall be adhered to in order to ensure the success and survival of the plantings installed in the dunes. Proof of adequate training, certifications and insurance may also be a requirement for landscape contractors prior to the commencement of work, as specified by the Borough.
- 3.3.4 While the Borough of Avalon assumes the role of facilitating the appropriate grants and aid for the Dune Vegetation Management Planning process; financial responsibilities and obligations will be allocated in accordance with the Memorandum of Understanding (MOU) between private property owners and the Borough of Avalon for the vegetation removal and replacement (**APPENDIX D**).

#### 3.4 Management Standards

- 3.4.1 The establishment of Priority Dune Vegetation Management Areas is essential to the overall success of the program. A prioritization system will allow the Borough to determine key areas where vegetation management is necessary on a priority basis to secure the integrity of the dune system and to ultimately protect the citizens of the Borough from damage associated with coastal storms or from the occurrence of dead or dying trees.
- 3.4.2 In areas where the implementation of the Plan includes both private and public property, a MOU will be executed by the affected parties. This MOU will lay out the proposed vegetation management and the allocation of resources. Prior to the commencement of work on private property, adequate site documents are necessary such as surveys (if available) and tax map of the site.

- 3.4.3 Once the site maps have been secured, site investigations will be conducted. Site investigations must be consistent with the Dune Vegetation Management protocols to determine areas where tree management is necessary. Trees that require management will be located and identified by species, size (dbh) and condition; i.e. living or dead, native or invasive species. This information will be plotted on a site plan. Trees that require management consistent with the Dune Vegetation Management Plan will be identified and physically marked in the field.
- 3.4.4 Management action will be separated into the following three categories:
- (a) The immediate removal of the aerial portion of dead trees (rationale: dead trees are not vegetation and must be removed in the interest of public safety);
  - (b) The removal of seedling and sapling Japanese Black Pine (rationale: clipping the aerial portion of seedling and sapling prevents the maturation and production of offspring while preventing crowding and displacement of native vegetation);
  - (c) The selective removal or trimming of trees in accordance with the Dune Vegetation Management Plan. Any mature trees that are removed will be cut at ground level. Heavy equipment will not be used in the dunes to remove such trees (rationale: this vegetation management will result in opening areas at ground level to provide adequate space for the planting of replacement native species to during the appropriate season).
- 3.4.5 The invasive vegetation replacement process shall take place with native species that are:
- (a) Drought tolerant,
  - (b) Less susceptible to disease,
  - (c) Less prone to wildfire and
  - (d) Known to provide better habitat for native wildlife. Please refer to the Proposed List of Dune Vegetation provided in (**APPENDIX E**), which lists native replacement vegetation according to salt spray tolerance and the overall location within the dune system.
- 3.4.6 The management process is initiated by installing a sand fence along the ocean-side of the area to be managed (see **APPENDIX I**). This installation shall be performed prior to the commencement of vegetation thinning, trimming or replacement in order to protect the dunes from wind erosion.
- 3.4.7 Invasive trees less than 6 feet in height will be hand sheered at ground level and the aerial portion of the seedlings / saplings will be removed.

- 3.4.8 An inventory of invasive mature trees will be conducted to determine which trees can be thinned, trimmed or removed to provide an area for their replacement by native vegetation. Invasive trees in a stand may be thinned as long as the distance between the remaining trees is no greater than fifteen feet and is at a minimum distance between trees of ten feet and are landward of the protective sand fence. The visual representation of this concept prepared by The Lomax Consulting Group and illustrated by the Taylor Design Group is located in **APPENDIX F**.
- 3.4.9 Replacement plantings are selected, hardened, installed and maintained consistent with Standards for Creating and Restoring Sand Dunes (**APPENDIX I**). The holes should be twice the size of the plant container for shrubs and three times the size of the tree container or root ball. The soil amendments of top soil and/or organic matter are used to back fill the hole to promote survivability of the plants. They are planted in a staggered row configuration. The visual representation of this concept prepared by The Lomax Consulting Group and illustrated by the Taylor Design Group is located in **APPENDIX F**.
- 3.4.10 The removal of the lower branches of the invasive trees that have been identified for eventual removal provides adequate open ground area for the establishment of the native plants and minimizes the efforts to remove them later. This process allows for the thinned and trimmed trees to remain in the dune system for the interim to maintain the integrity of the dune structure until the replacement vegetation is established.
- 3.4.11 Once the native plants are established consistent with the Plan, the remaining invasive plants will be removed and replaced by native species.
- 3.4.12 The replacement vegetation will be inspected in the spring and fall to ensure successful establishment. Plant replacement is required for dead plants.
- 3.4.13 Plants will be maintained and may be trimmed to promote their health consistent with the approved Plan.
- 3.4.14 Safe guards to assure that the overall dune system is protected, to the maximum extent practical, have been incorporated into the design of the DVMP. They include:
- (a) Live native vegetation will be retained to the maximum extent practical;
  - (b) The entire root system of the trees to be removed will be preserved without disturbance to retain the structure within the dune system;

- (c) Cutting and removal of the invasive trees will be accomplished using trained professionals;
  - (d) The utmost care, is required and
  - (e) Prior to removal of the remaining stand of invasive trees, the replacement native plants must survive into the second growing season (see graphic – **APPENDIX F**);
  - (f) The Pilot Demonstration Project in the vicinity of 74<sup>th</sup> Street provides an integral safeguard that allows the community to explore different techniques for vegetation control and obtain first hand field data that can be applied throughout the Borough's DVMP (see section 4);
  - (g) The management process takes this overriding theme of safeguards to the next level by developing a concept that continuously preserves vegetation throughout the process;
  - (h) The installation of a sand fence along the along the ocean-side of any area proposed for management ensures that the planted native species will be sheltered from harsh winds from the onset of the process (additional sand fence may be employed to minimize sand movements).
- 3.4.15 Inspections and monitoring are important elements of the DVMP by providing continued feedback concerning the successes and necessary revisions of the Program. It is proposed that the DVMP Base Map (**APPENDIX G**) be used to track priority restoration areas and facilitate monitoring success of the Dune Restoration Plan. It is important to note that this visual representation will be updated over the course of the project.
- 3.4.16 Pre-inspections and Post-inspections, including photo-documentation, of areas involved in dune management and restoration will be incorporated into the project proposal. Reports of success of replacement native plants will be submitted to the appropriate governing bodies for monitoring purposes. These reports will include an assessment of plant survival and coverage annually until the plants are established. The planting success and resulting site conditions will be documented with photographs.

## **SECTION 4. PILOT DEMONSTRATION PROJECT**

### 4.1 Pilot Demonstration Project

A Pilot Demonstration Project was incorporated into the design of the Dune Vegetation Management Plan in order to test the effectiveness of the standards and techniques of the plan. It has been designed to understand and to address issues discovered by smaller scale projects that exhibit the same dune restoration aspects encountered in the proposed Plan. The area

chosen for the Pilot Demonstration Project is located at the oceanside end of 74<sup>th</sup> Street. This area was chosen because it exhibited the following three elements that are representative of invasive plant conditions found in the Borough:

- (a) A dune area having a significant monoculture stand of Japanese black pine that is impacting a landowner and that is expanding into the Borough dune system south of 74<sup>th</sup> Street (**PHOTO 7, 8 and 9 – APPENDIX A**);
- (b) A dune area having a limited mixed stand of Japanese black pine north of 74<sup>th</sup> Street;
- (c) The Borough 74<sup>th</sup> Street end and associated beach path containing the invasive species (**PHOTO 10 – APPENDIX A**). This test area contains living and dead Japanese black pine occurring on adjoining Borough and private property. Prior to the inventory conducted during August of 2009, two meetings were conducted between representatives of the Borough, Joseph L. Lomax and the owners of the private property along 74<sup>th</sup> Street. The purpose of landowner meetings were to discuss the rate of growth of this invasive species in the back dune areas and to ensure support and cooperation throughout the Dune Vegetation Management process. This small but representative Pilot Demonstration Project will evaluate techniques employed in vegetation control and replacement, in addition to monitoring the integrity of the affected dunes.

#### 4.2 Management techniques to be Demonstrated

The major components that will be evaluated through the Pilot Demonstration Project include:

- (a) Thinning – removal of an aerial portion of selected, invasive or problematic trees at a specific site,
- (b) Trimming – removal of the lower limbs of the trees, and candles, and
- (c) The replacement of vegetation with native species with the criteria specified in the Management Standards. Adjustments to the Plan will be made in a manner consistent with the intent of this Management Plan and in responsive to the best available practices for landscape management in the dune system.

## **SECTION 5. DUNE VEGETATION MANAGEMENT PLAN APPROVAL PROCESS**

### 5.1 Review and Approval Process

The Dune Vegetation Management Plan (DVMP) promotes the use of management standards and techniques that maintain a healthy, diverse dune system comprised primarily of native species. This Plan will receive reviews by the public and agencies of the Borough in consultation with the Avalon Environmental Commission and other interested agencies of government as noted below.

- 5.1.1 The DVMP draft outline was reviewed and approved by the Borough for the purposes of discussion with the other land use agencies.
- 5.1.2 Inter-governmental coordination occurred through discussions with the NJ Department of Environmental Protection, the U.S. Fish and Wildlife Service and Natural Resources Conservation Service of the US Department of Agriculture.
- 5.1.3 The DVMP was drafted by The Lomax Consulting Group.
- 5.1.4 The Draft Plan will be reviewed by the Avalon Environmental Commission and Borough Administrator.
- 5.1.5 The revised Draft Plan will be submitted to the public and agencies for their review and comments.
- 5.1.6 The Plan will be refined by The Lomax Consulting Group based on public and technical comments.
- 5.1.7 The Plan will be presented to the Borough for its review, comments and recommendations to Council.

## 5.2 Dune Vegetation Management Plan Implementation

- 5.2.1 After review and approval by Borough Council (incorporating their changes), the appropriate Plan elements will be prepared for adoption into the Borough Dune Ordinance.
- 5.2.2 The proposed changes to Borough Dune Ordinances will be submitted to NJDEP for their review and approval, as their interest appears.
- 5.2.3 Upon receiving all required inputs and approvals, the DVMP will then be integrated into the appropriate Borough Ordinances (**APPENDIX H**).
- 5.2.4 Public meeting(s) will be conducted to inform the interested public and landscapers of the purpose and provisions of the DVMP.

## SECTION 6. CONCLUSION

The protection of the dune system by maximizing native dune vegetation and by the proper management of these natural resources is an important issue facing the Borough of Avalon. This issue extends beyond the scope of traditional environmental protection and natural resource conservation to a much broader array of public health and safety concerns. A well-maintained dune system provides a protective barrier from coastal storms for the community. This Dune Vegetation Management Plan creates a framework for the community to return the dune vegetation to its natural state. It identifies specific roles of individuals within the community and the management standards that safeguard the integrity of the dunes, while allowing vegetation management and dune restoration. The Dune Vegetation Management Plan not only outlines the specifics of management practices to be applied in the field, but also provides for a Pilot Demonstration Project to ensure that best management practices are being utilized based upon experience derived from actual field operations within the Borough of Avalon. Furthermore, the Plan lays out the approval process to ensure that the goal of a healthy and diverse ecosystem is connected to the Boroughs public policy process. Accordingly, the Dune Vegetation Management Plan is an integral part of the Community Forestry Management Plan. It incorporates public and governmental reviews, and ultimately it will become included in the Borough Master Plan and appropriate Land Use Ordinances.

The Plan provides an opportunity for the Borough and the landowners to address, in a cooperative manner, dune vegetation management issues. Further, the Plan provides the basis for seeking funding support for implementation of the management program from such funding sources as the U.S. Fish and Wildlife Service and the NJDEP Community Forestry Management Program. In addition, the Plan establishes the operating standards and an agreement that the Borough and cooperating landowners can utilize to share dune vegetation management responsibilities and costs. In conclusion, the Dune Vegetation Management Plan recognizes that the dune system of the Borough of Avalon is a critical asset of the community and requires continuing management to ensure that the dune system will continue to:

- (a) Serve the Borough as a protective buffer dissipating coastal storm energy,
- (b) Maintain a bank of sand to replenish the beach system,
- (c) Support a diversity of habitats for adapted plants and wildlife and
- (d) Create unique aesthetic appeal of the community

## SECTION 7.

## SELECTED REFERENCES

- Collins, Berly Robichaud and Karl H. Anderson. 1994. *Plant Communities of New Jersey- A Study in Landscape Diversity*. Rutgers University Press, New Brunswick, NJ. 287p.
- Duncan, Wilbur H. and Marion B. Duncan. 1987. *The Smithsonian Guide to Seaside Plants of the Gulf and Atlantic Coasts- from Louisiana to Massachusetts, Exclusive of Lower Pennisular Florida*. Smithsonian Institution Press, Washington D.C. 409p.
- Elias, Thomas S. 1980. *The Complete Trees Of North America Field Guide and Natural History*. Van Nostrand Reinhold Company, New York, NY. 948p.
- Fernald, Merritt Lyndon, 1950. *Gray's Manual of Botany*. Dioscorides Press, Portland, OR. 1632p.
- Fournier, Mike (author), and Christopher Miller and William Skaradek (Editors). 2009. *Standards for Creating and Restoring Sand Dunes from Massachusetts to North Carolina*. Cape May Plant Material Center (National Resource Conservation Service). Swainton, NJ.
- Hightshoe, Gary L. 1988. *Native Trees, Shrubs, and Vines for Urban and Rural America. A Planting Design Manual for Environmental Designers*. Van Nostrand Reinhold, New York, NY. 819p.
- Hough, Mary Y. 1983. *New Jersey Wild Plants*. Harmony Press, Harmony, NJ. 414p.
- Leatherman, Stephen P. 1979. *Barrier Islands From the Gulf of St. Lawrence To The Gulf of Mexico*. Academic Press, New York, NY. 325p.
- Lomax, Joseph L.; Joan M. Galli and Anne E. Galli. 1980. *The Wildlife of Cape May County, New Jersey – A Habitat Guide to the Vertebrate Fauna*. Center for Environmental Research Stockton State College. Pomona, NJ. 93p.
- Manley, Sean and Robert Manley. 1968. *Beaches: Their Lives, Legends, and Lore*. Chilton Book Company, New York, NY. 383p.
- Martin, Alexander C.; Herbert S. Zim and Arnold L. Nelson. 1951. *American Wildlife & Plants A Guide to Wildlife Food Habits – The use of Trees, Shrubs, Weeds and Herbs by Birds and Mammals of the United States*. Dover Publications, New York, NY. 500p.
- Martine, Christopher T. 2002. *Shrubs and Vines of New Jersey and the Mid-Atlantic States*. New Jersey Forest Service Forest Resource Foundation Center, Jackson, NJ. 114p.
- Martine, Christopher T. 2000. *Trees of New Jersey and the Mid-Atlantic States*. New Jersey Forest Service Forest Resource Foundation Center, Jackson, NJ. 112p.
- Miller, Chris. 2009. Personal Communications. Natural Resources Conservation Service Plant Material Center. Swainton, NJ.
- Petry, Loren C. 1963. *A Beachcomber's Botany*. The Chatman Press, Old Greenwich, CT. 158p.
- Silberhorn, Gene M. 1982. *Common Plants of the Mid-Atlantic Coast- A Field Guide*. The John Hopkins University Press, Baltimore, MD. 256p.

**Selected References- cont'd**

State of New Jersey. 2001. Island Beach State Park Common Plants. Department of Environmental Protection, Division of Forest and Parks. Trenton, NJ.

Stuckey, Irene H. and Lisa Lofland Gould. 2000. *Coastal Plants from Cape Cod to Cape Canaveral*. The University of North Carolina Press, Chapel Hill, NC. 305p.

U.S. Fish and Wildlife Service. 2005. Native Plants for Wildlife Habitat and Conservation Landscaping, Chesapeake Bay Field Office, Annapolis, MD.

**APPENDIX A.  
Photographs**

## PROJECT PHOTOGRAPHS



Photograph 1.

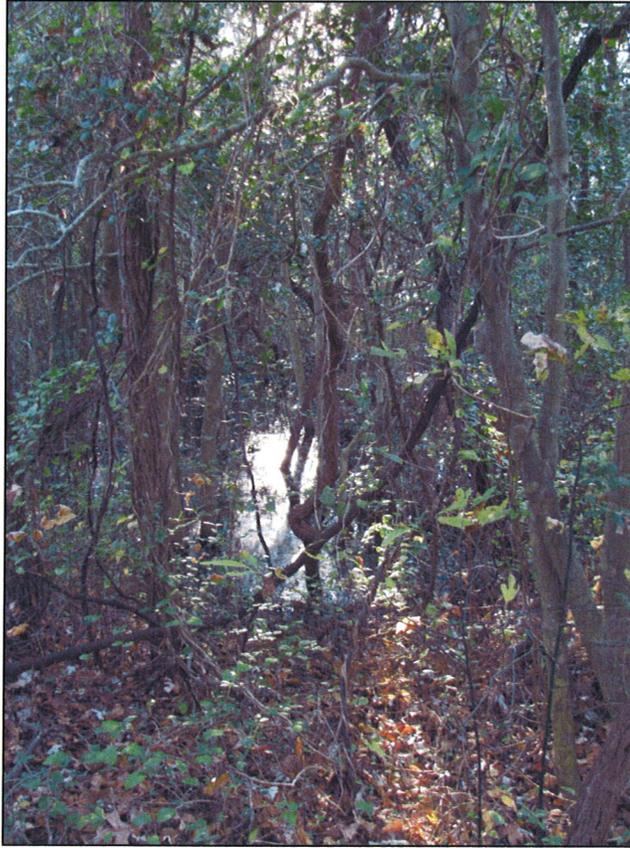
The dune system is a community asset that is comprised of diverse biotic communities adapted to surviving coastal conditions.



Photograph 2.

The back dunes have been dominated by native trees and shrubs, however, the Japanese black pine has become established in many areas of the community and has replaced native vegetation.

## PROJECT PHOTOGRAPHS



Photograph 3.

A hardwood swamp wetland has become established in the interdunal swale.



Photograph 4.

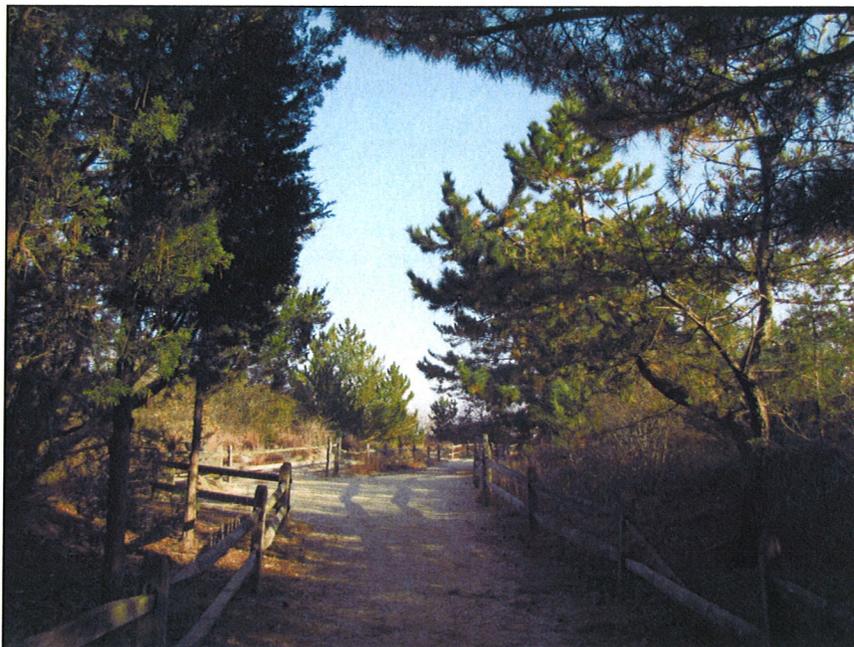
Extensive, dune areas of the Borough have benefited from the installation of sand trapping fences and the planting of dune grasses. Old sand fence supports illustrate the expansion of the dune in some areas of the Borough.

## PROJECT PHOTOGRAPHS



Photograph 5.

The maritime forest supports a unique assemblage of trees and shrubs adapted to the western portion of the dune ecosystem.



Photograph 6.

The Japanese black pine was planted to stabilize the back dune system; however, its invasive nature has resulted in the displacement of native vegetation.

## PROJECT PHOTOGRAPHS



Photograph 7.

The dense growth of the Japanese black pine has resulted in the displacement of native species except for poison ivy and Virginia creeper. The needle drop and pine cones create a fire-prone environment in close proximity to residences. This stand on the south side of 74<sup>th</sup> Street is indicative of the Japanese black pine monoculture condition.



Photograph 8.

Japanese black pine can attain significant height. Their rapid growth results in dense visual barriers and replacement of natural coastal ecosystems, as experienced on the south side of 74<sup>th</sup> Street.

## PROJECT PHOTOGRAPHS



Photograph 9.

The Japanese black pine has invaded the natural stand of vegetation on the north side of 74<sup>th</sup> Street, not only out competing the native plants, but also establishing itself in the natural dunes oceanward of the primary dunes.



Photograph 10.

The 74<sup>th</sup> Street end and beach path is partially lined by Japanese black pine, some of which have crowded out native vegetation and some of which are dying (right side).

**APPENDIX E:  
Proposed List of Dune Vegetation  
Comments from  
Chris Miller, USDA, Plant Material Center (November 4, 2009)**



## PROPOSED LIST OF DUNE VEGETATION

Adapted vegetation is an integral part of the overall dune system that is vital to the protection to the Borough from coastal storms. This vegetation not only aids sand deposition and accumulation but also serves to retain the sand in the dune system. Accordingly, the selection of plants that will survive and flourish in the harsh environment of the dune system is critical. The Avalon dune system is an expansive and diverse ecosystem exposed to wind and salt spray. The dune soils are sandy; and as such are droughty. In recognition of these conditions, the following vegetation list has been divided into three main categories based upon exposure and soil moisture conditions: (A) Salt Spray Tolerant Vegetation, (B) Sheltered Upland Dune Vegetation and (C) Sheltered Wetland Dune Vegetation based on the species tolerance of conditions and location in the dune system. The criteria for selection of the following plants for dune revegetation with native species include (1) their adaptation to survival in the dune environment; (2) resistance to disease and pests; (3) they do not require watering after they are established; (4) they may be pruned to control shape and height, if trimming is begun early in the tree/shrub development, and (5) they are available from nurseries.

The following information has been provided through literature review, direct dune observations in Avalon and Island Beach State Park, in addition to personal experience and communications with other qualified professionals in the field. One asterisk (\*) indicates that this species is used by wildlife for food (including pollinators) and cover. Two asterisks (\*\*) indicates that the plant has high wildlife value. (E) indicates that the plant is evergreen.

### A. Salt Spray Tolerant Vegetation

1. **Trees:**

<u>Common Name</u>	<u>Scientific Name</u>
Eastern Red Cedar *(E)	<i>Juniperus virginiana</i>
Black Cherry **	<i>Prunus serotina</i>
Winged Sumac **	<i>Rhus copallina</i>
Fragrant Sumac **	<i>R. aromatica</i>
  
2. **Shrubs:**

<u>Common Name</u>	<u>Scientific Name</u>
Northern Bayberry **(E)	<i>Morella pensylvanica</i>
Wax Myrtle *	<i>M. cerifera</i>
Beach Plum *	<i>Prunus maritima</i>
Groundsel *	<i>Baccharis halimifolia</i>
Bearberry (E)	<i>Arctostaphylos uva-ursi</i>
Beach-heather (E)	<i>Hudsonia tomentosa</i>

*Over 30 years of environmental excellence.*



## Salt Spray Tolerant Vegetation (continued)

<b>3. Vines:</b>	
<u>Common Name</u>	<u>Scientific Name</u>
Virginia Creeper **	<i>Parthenocissus quinquefolia</i>

## B. Sheltered Upland Dune Vegetation

<b>1. Trees:</b>	
<u>Common Name</u>	<u>Scientific Name</u>
Pitch Pine **(E)	<i>Pinus rigida</i>
Eastern Red Cedar *(E)	<i>Juniperus virginiana</i>
Sassafras **	<i>Sassafras albidum</i>
Hackberry **	<i>Celtis occidentalis</i>
American Holly *(E)	<i>Ilex opaca</i>
Wild Persimmon **	<i>Diospyros virginiana</i>
Scarlet Oak **	<i>Quercus coccinea</i>
Black Oak **	<i>Q. valutina</i>
Blackjack Oak **	<i>Q. marilandica</i>
Scrub Oak **	<i>Q. ilicifolia</i>
Pignut Hickory *	<i>Carya glabra</i>
Mockernut Hickory *	<i>C. tomentosa</i>
Hop-hornbeam *	<i>Ostrya virginiana</i>
<b>2. Shrubs:</b>	
<u>Common Name</u>	<u>Scientific Name</u>
Northern Bayberry **(E)	<i>Morella pensylvanica</i>
Wax Myrtle *	<i>M. cerifera</i>
Beach Plum *	<i>Prunus maritime</i>
Groundsel *	<i>Baccharis halimifolia</i>
Inkberry Holly **(E)	<i>Ilex glabra</i>
Low Rose **	<i>Rosa carolina</i>
Sweet Fern *	<i>Comptonia peregrina</i>
Toughleaf Dogwood	<i>Cornus asperifolia</i>
<b>3. Vines:</b>	
<u>Common Name</u>	<u>Scientific Name</u>
Climbing Bittersweet *	<i>Celastrus scandens</i>
Trumpet Vine *	<i>Campsis radicans</i>



### C. Sheltered Wetland Dune Vegetation (Interdunal Swales)

#### 1. Trees:

<u>Common Name</u>	<u>Scientific Name</u>
Red Maple *	<i>Acer rubrum</i>
Serviceberry *	<i>Amelanchier arborea</i>
Shadbush *	<i>A. canadensis</i>
Southern Red Oak *	<i>Quercus falcata</i>
Willow Oak *	<i>Q. phellos</i>
Black Gum *	<i>Nyssa sylvatica</i>
Sweetbay *(E)	<i>Magnolia virginiana</i>
Atlantic White Cedar (E)	<i>Chamaecyparis thyoides</i>

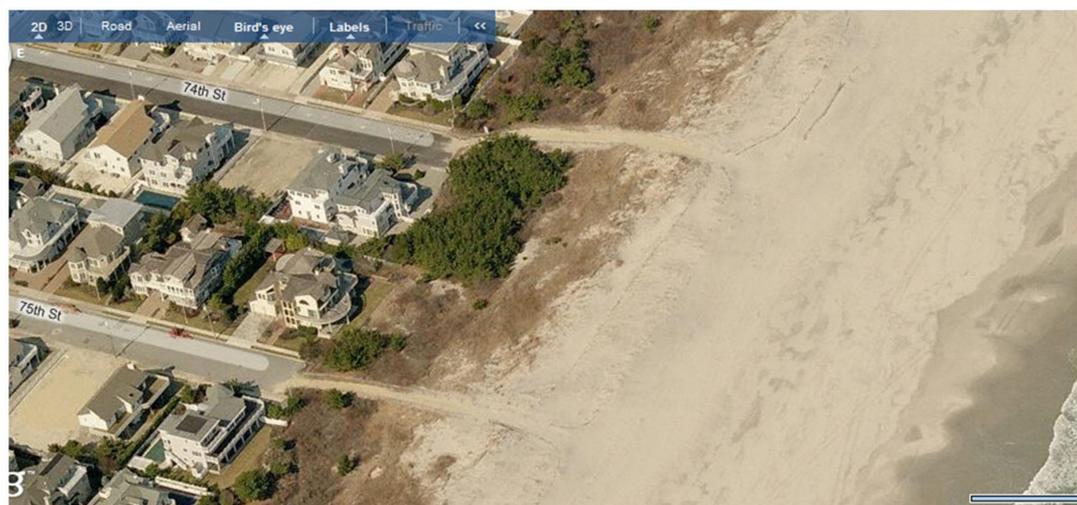
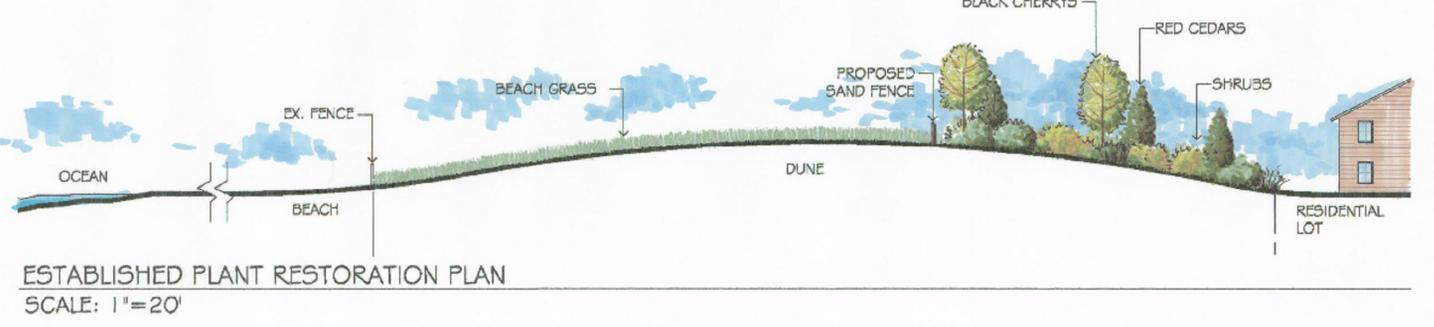
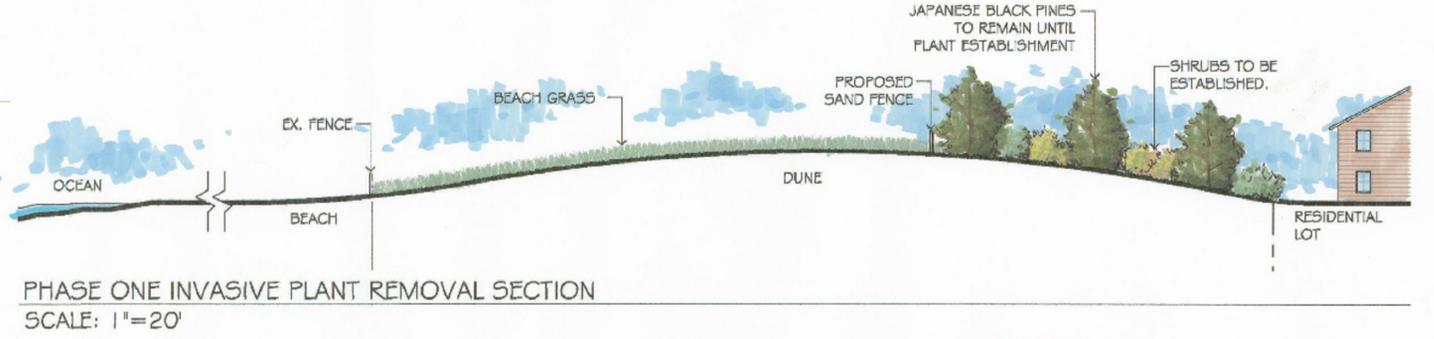
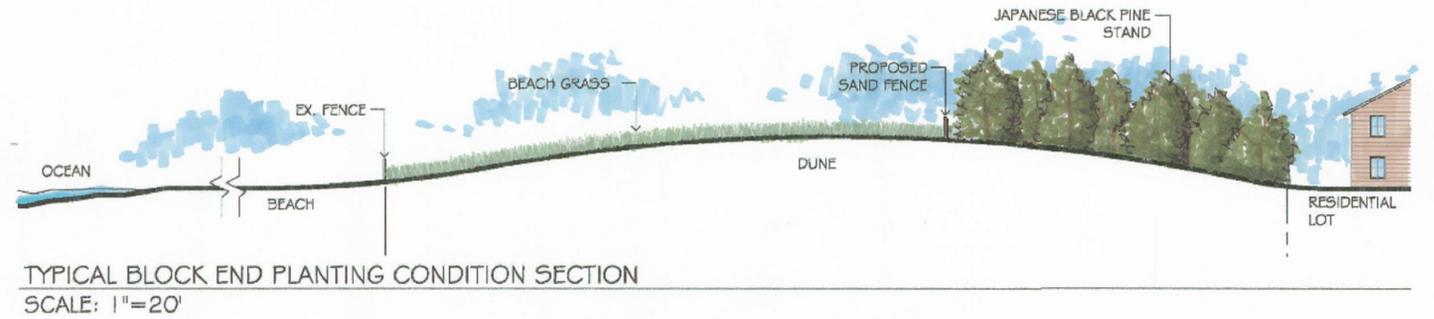
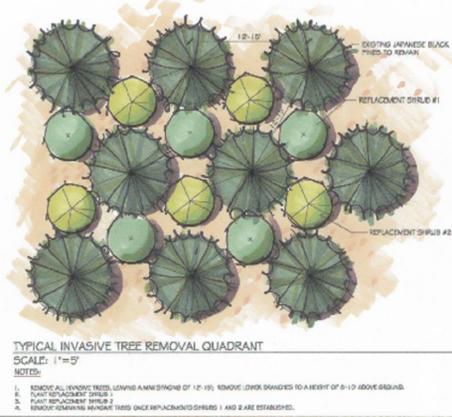
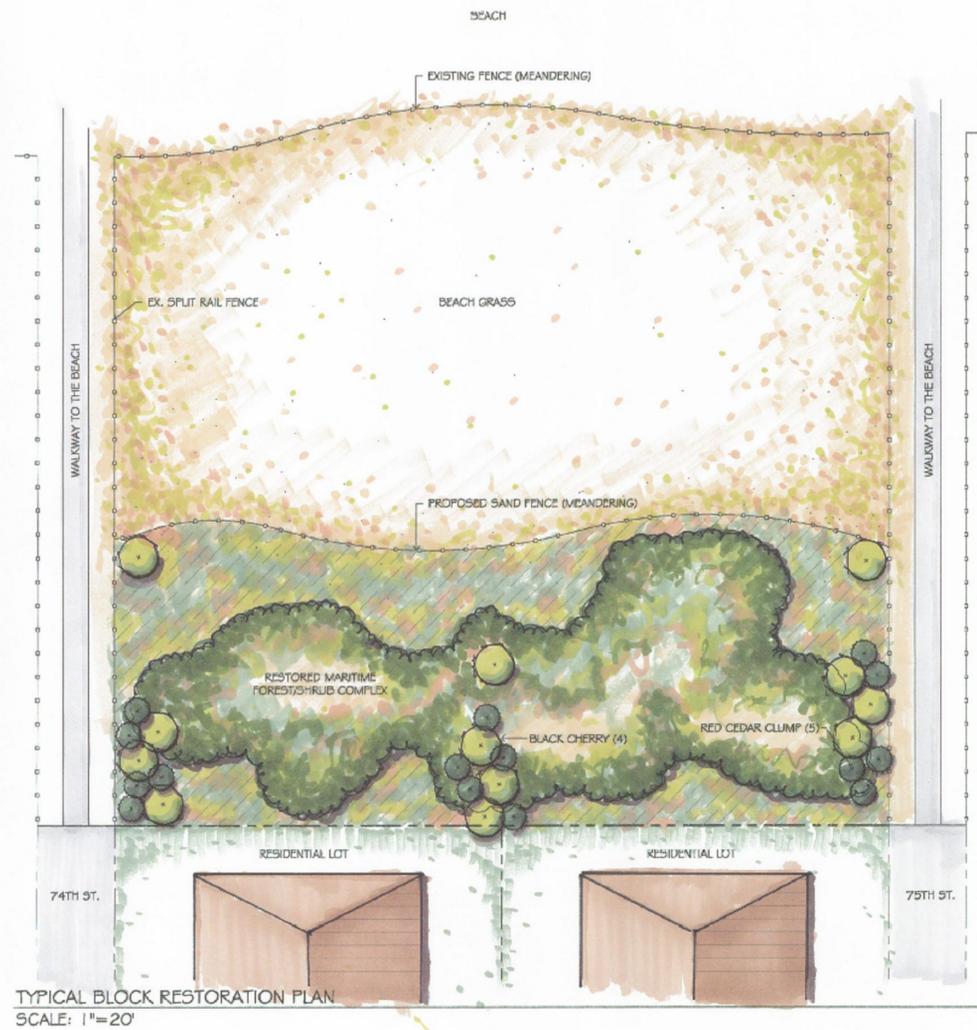
#### 2. Shrubs:

<u>Common Name</u>	<u>Scientific Name</u>
Maleberry *	<i>Lyonia ligustrina</i>
Black chokeberry *	<i>Photinia melanocarpa</i>
Red chokeberry *	<i>P. pyrifolia</i>
Inkberry **(E)	<i>Ilex glabra</i>
Southern Arrowwood **	<i>Virburnum dentatum</i>
Sweet Pepperbush *	<i>Clethra alnifolia</i>
Black Huckleberry **	<i>Gaylussacia baccata</i>
Winterberry **	<i>Ilex verticillata</i>
Highbush Blueberry **	<i>Vaccinium corymbosum</i>

LAST REVISED : 11/2/09

Files/Active/08-563.1/List of Proposed Dune Vegetation 11\_2\_09.doc

**APPENDIX F.  
Dune Restoration Plan Strategy  
Prepared by  
The Lomax Consulting Group  
Illustrated by the Taylor Design Group**



# Dune Restoration Plan



**BOROUGH OF AVALON**  
CAPE MAY COUNTY, NEW JERSEY



Prepared under the direct supervision of  
**Scott D. Taylor AICP, LLA, PP, LEED AP**  
DATE: AUGUST 4, 2009  
SCALE: NOT TO SCALE



**APPENDIX I**  
**Standard for Creating and Restoring Sand Dunes**  
**From Massachusetts to North Carolina**

**STANDARD**  
**for**  
**CREATING and RESTORING SAND DUNES**  
From Massachusetts to North Carolina

Written by: Mike Fournier, Former PMC Manager

Edited by:

Christopher Miller, Regional Plant Specialist, USDA-NRCS  
William Skaradek, Manager, Cape May Plant Materials Center

**DEFINITION:** Effective establishment and maintenance of physical (living or inert) barriers which manage the surface movement of shifting coastal beach sands.

**PURPOSE:** To develop a system of coastal sand dunes to protect human lives, personal property, and community infrastructures. A secondary benefit of such developments is the creation and protection of critical habitat of threatened and endangered bird species.

**WHERE APPLICABLE:** Along ocean and bay shorelines; where blowing sands and storm waters may cause damage to human and wildlife resources.

**METHODS and MATERIALS:** Sand dunes naturally form on barrier islands, shorelines exposed directly to the ocean, and inland sand deposits. The source of this wind born sand is the ocean or its bays. These parallel ridges of sand form perpendicular to prevailing winds and grow toward its source of sand. Periodic storm events and human activity continually alter their development and original configuration. Once developed the sand dunes provide adequate protection from moderate storms and tides. The existence and maintenance of vegetation on dunes provides a network of root and foliage which holds unconsolidated sand in place. American beachgrass is the dominant, naturally occurring, vegetation of the frontal dunes of the northern Mid-Atlantic and New England coasts. From Virginia beach southward through the Carolinas, sea oats becomes the dominant foredune plant. When beachgrass or sea oats are established with structural resources and other dune species, a formidable well-anchored storm barrier is established, capable of saving major public and private assets. Establishing curvilinear foot paths or wooden crosswalks through or over the sand dunes, bordered by sand fencing, is necessary where foot or vehicular traffic is expected.

## 1. VEGETATION

- A. **Plant Materials:** The foliage of most sand dune species filters sand from the wind. The reduction of wind velocity near the dune's surface by vegetation allows sand to be deposited. The root mass of these plant species adapted to the sand dune environment are typically deep and extensive, anchoring the dunes to their foundation. When possible only certified cultivars, which have been tested on similar sites, should be utilized for protecting valuable coastal resources.

1.) Cultivar Releases recommended for stabilizing sand dunes; all cultivars listed were released by the USDA- Natural Resources Conservation Service's Plant Materials Program:

- a.) 'Cape' american beachgrass (*Ammophila breviligulata*)
- b.) 'Atlantic' coastal panicgrass (*Panicum amarum* var. *amarulum*)
- c.) 'Northpa' bitter panicgrass (*Panicum amarum*)
- d.) 'Avalon' saltmeadow cordgrass (*Spartina patens*)
- e.) 'Monarch' seaside goldenrod (*Solidago sempervirens*)
- f.) 'Wildwood' bayberry (*Myrica pensylvanica*)
- g.) 'Ocean View' beach plum (*Prunus maritima*)
- h.) 'Sandy' rugosa rose (*Rosa rugosa*)
- i.) 'Emerald Sea' shore juniper (*Juniperus conferta*)

2.) Non-Cultivar Releases suitable for adding plant diversity on sand dunes:

- a.) seashore little bluestem (*Schizachyrium scoparium* var. *littoralis*)
- b.) sea oats (*Uniola paniculata*)
- c.) switchgrass (*Panicum virgatum*)
- d.) partridge pea (*Chamaecrista fasciculata*)
- e.) beach pea (*Lathyrus maritimus*)
- f.) eastern red cedar (*Juniperus virginiana*)
- g.) groundsel tree (*Baccharis halimifolia*)

**NOTE:** The cultivars listed were developed specifically for sand dune stabilization and should be specified and used when available. By using cultivars developed for such a harsh environment, the risk of plant failure is reduced.

In addition, when developing a planting plan for a dune system, it is imperative to plant species in their zone of adaptation. The species best adapted to the frontal dune face are american beachgrass, bitter panicgrass, and sea oats (Delmarva Peninsula and south). As you move onto the back of the frontal dune or into the secondary dune system, the additional species listed above may be incorporated into the planting as available. By broadening the plant diversity, the risk of plant failure is further minimized. See (Diagram 1) for plant zonation guidelines.

## B. Plant Establishment

- 1.) **(Cape) american beachgrass** (*Ammophila breveligulata*)- Beachgrass is successionaly classified as a pioneering type species; it is about the only species capable of surviving the harsh environmental conditions of the frontal dunes. For initially stabilizing a dune system, this species is the most reliable and commercially available option. Once established it rapidly spreads by a rhizomatous root system, developing a soil binding network of inter-woven roots.

Date = November 1 to April 1; under non-frozen soil conditions

Planting Unit = a minimum of two stems (culms) per hole

Method = hand placement, or use of a vegetable or tree planter

Size = 16 to 18 inch long stems,  $\geq \frac{1}{4}$  inch in diameter

Depth = culms placed approximately 8-10 inches deep

Spacing: severe sites = 12" X 12"

normal sites = 18" X 18"

stable sites = 24" X 24"

Notes:

- Plant  $\geq 100$  feet of horizontal distance from the mean high tide water line to ensure success
- Plant a minimum of 10 parallel rows; stagger (off-set) rows to maximize protection
- Firm soil around plants to eliminate air pockets
- If utilizing dredged fill allow salts to leach out before planting and rains to compact sands

2.) **(Northpa) bitter panicgrass** (*Panicum amarum*)– This perennial, warm-season grass with a prostrate growth habit spreads slowly from short, strong rhizomes initially forming open clumps. Over time these clumps can fuse to form a dense mat of vegetation. Since this grass produces little viable seed it must be planted vegetatively.

Date: potted plants = April 1 to May 1

bare root = November 1 to April 15

stem cuttings = April 1 to May 15

Planting Unit = single bare-root or containerized seedling or stem division; 12 - 18 inches tall

Depth: potted/bareroot = 2 inches deeper than the nursery depth

Stem cuttings= place on a 45 degree angle in a 8-10 inch hole or slit leaving the top 6-10" of stem exposed.

Method: plants = hand placed, or using a vegetable transplanter

Spacing: Potted/bareroot = 2 feet apart in 2-3 foot staggered rows.

Stem cuttings= minimum of three stems/hole, spaced 2 feet apart in staggered 2-3 foot rows

3.) **(Atlantic) coastal panicgrass** (*Panicum amarum var. amarulum*)-

This warm season bunch-like grass is a post stabilization species thriving from the crest of the frontal dune to inland sites. It is the only dune stabilization species which has been directly seeded on to the sand dunes successfully. Potted plants and stem divisions can also be successfully established on these severe sites. The annual foliage emerges from a deep fibrous perennial root system with short lateral rhizomes. This species can be successfully planted with or over seeded into stands of American beachgrass. The closely related switchgrass is not as well adapted to sand dune conditions due to its lower seedling vigor. However, it is a good alternative, especially north of Long Island where coastal panicgrass is not native.

Date: Seeding: over seeding = April 1 to May 1

Dormant seeding = November 1 to April 15

Planting = April 1 to May 15

Planting Unit = single bare-root or containerized seedling or division; 12 - 18 inches tall

Seeding rate = 8 to 12 Lbs. of Pure Live Seed (PLS) per acre

Depth: plants = 2 inches deeper than the nursery depth

seed = drilled 1½ to 2½ inches deep

Method: seed = hand broadcast/incorporated, garden seeder (single row, push) or mechanically operated drill or drop seeder

plants = hand placed, or use a vegetable or tree transplanter

Spacing: plants = place 2-4 feet apart within a row with rows spaced 6-8 feet apart  
seed = 3' to 10' row spacing

- 4.) **Sea oats (*Uniola paniculata*)- Adapted only south of the Delaware Bay (Delmarva Peninsula & south).** Within its range, sea oats is the most important plant in the pioneer (frontal dune) zone. Like beachgrass, it flourishes best where sand is drifting and accumulating. However, unlike beachgrass, it persists as a perennial cover after the sand has been stilled but dies back to the ground over the winter. For initial stabilization of a sand dune, it is best to interplant both species.

Date = March 1 to April 15

Planting Unit = one bare-root or potted plant

Depth = 2 inches below the nursery grown depth

Method = hand placed, or vegetable planter

Size =  $\geq$  24-36 inch stem

Spacing = 18 to 36 inch row spacing with plants placed 18 inches apart within a row. May be interplanted with american beachgrass by alternating rows of each species.

- 5.) **(Avalon) saltmeadow cordgrass (*Spartina patens*)-** Although typically associated with tidal salt marshes, saltmeadow cordgrass also naturally occurs in the secondary and back dune areas. Predominantly inhabiting inter-dune troughs and low blow-out areas. It is dominant in these micro-sites since most other sand dune species can not tolerate wet to saturated soil conditions. The trailing rhizomes of saltmeadow cordgrass are slender, but form dense mats near the surface. It is vegetatively established on normal sites using freshly harvested stems (culms) or containerized plants on severe locations.

Date = May 1 to June 15

Planting Unit = 3 to 5 live stems placed bare-root or containerized

Depth = 2 inches below the nursery grown depth

Method = hand placed, or vegetable planter

Size =  $\geq$  12 inches

Spacing = 18 to 36 inches depending on the severity of the planting site

Notes: Utilize this species in low elevation sites of sand dunes which are frequently moist or inundated.

- 6.) **Switchgrass** (*Panicum virgatum*)– This warm-season, bunchgrass commonly grows in back dune swales and upper margins of tidal marshes. Seedling vigor is lower than in the closely related coastal panicgrass and therefore is not as well adapted for seeding on actively shifting sand dunes. However, switchgrass is a good alternative to coastal panicgrass north of Long Island, which is beyond the native range of coastal panicgrass.

Date: Seeding: over seeding = April 1 to May 1  
dormant seeding = November 1 to April 15  
planting = April 1 to May 15

Planting Unit = single bare-root or containerized seedling or division; 12 - 18 inches tall

Seeding rate = 8 to 12 Lbs. of Pure Live Seed (PLS) per acre

Depth: plants = 2 inches deeper than the nursery depth  
seed = drilled 1½ to 2½ inches deep

Method: seed = hand broadcast/incorporated, single row garden seeder, or mechanically operated drill or drop seeder

plants = hand placed, or use a vegetable or tree planter

Spacing: plants = 4' X 4'

seed = 3' to 10' row spacing

- 7.) **Seacoast bluestem** (*Schizachyrium littorale*)– This native, warm-season grass is a coastal variation of the inland little bluestem. It differs visually with a more prostrate growth habit. Found in scattered open clumps in the back dunes, it rarely forms a solid stand, but is found mixed with other species such as beach heather, seaside goldenrod, beachgrass, bayberry, beach plum.

Date = March 1 to April 15

Planting Unit = one bare-root or potted plant

Depth = 2 inches below the nursery grown depth

Method = hand placed or vegetable planter

Size = ≥ 12-24 inch stem

Spacing = 24 to 36 inch row spacing with plants placed 24 inches apart within a row. Plant in the backdunes where sand is stable. May be interplanted with switchgrass, coastal panicgrass, saltmeadow cordgrass, seaside goldenrod, and beach or partridge pea.

8.) **(Monarch germplasm) seaside goldenrod** (*Solidago sempervirens*) – This perennial forb adds color and variety to a dune planting. It is a major food source on the fall migration of the Monarch butterfly. From its inconspicuous green basal leaves in winter into early summer arises a brilliant yellow flower cluster in early fall. Although often blamed for causing allergies, it is actually an insect pollinated plant. (Ragweed is the real culprit).

Date = March 1 to May 15

Planting Unit = one bare-root or potted plant

Depth = 2 inches below the nursery grown depth

Method = hand placed or vegetable planter

Size =  $\geq$  12-18 inch stem

Spacing = 24 to 36 inch row spacing with plants placed 24 inches apart within a row. Plant in the backdunes where sand is stable. May be interplanted with switchgrass, coastal panicgrass, saltmeadow cordgrass, and beach or partridge pea.

9.) **Beach pea and partridge pea** (*Lathyrus maritimus/Chamaecrista fasciculata*) Beach pea is adapted from New Jersey- north and partridge pea, an annual reseeding legume, from Massachusetts to the Carolinas. These native legumes have good wildlife value as edible seed for both upland game and shore birds.

**Partridge pea (seed only)**

Date: Seeding: over seeding = April 1 to May 15

dormant seeding = November 1 to April 15

Seeding rate = 2-4 pounds of Pure Live Seed (PLS) per acre.

Depth: = seed drilled 1½ to 2½ inches deep in stilled sand

Method: seed = hand broadcast/incorporated, single row garden seeder, or mechanically operated drill or drop seeder

**Beach pea (plants only)**

Planting Unit = single bare-root or containerized seedling or division; 12 - 18 inches tall  
planting = April 1 to May 15

Depth: plants = 2 inches deeper than the nursery depth

Method: plants = hand placed, or use a vegetable or tree planter

Spacing: plants = 4' X 4'  
seed = 3' to 10' row spacing

**10.) Shrubs and Trees** (bayberry, beachplum, rugosa rose, groundsel)- Medium sized shrubs and small trees naturally dominate the back dune zone of New Jersey's barrier islands. The shrubs begin to co-inhabit the mid secondary dunes. Once extensive stands of bayberry, beach plum, pitch pine and other woody species covered these islands where houses now stand. The shrub species which are well adapted to the dune ecosystem are capable of either layering or root suckering. The trees and shrubs of the sand dunes have deep tap root systems for supplying adequate moisture and nutrients. Each species utilized for back dune stabilization has its own unique attributes. Beach plum has a colorful bloom in spring which yields a tasty succulent cherry like fruit. Bayberry roots have nodules which enable it to fix atmospheric nitrogen similar to legumes; it also produces aromatic fruit and leaves. The thorny stems of rugosa rose are useful in directing pedestrian traffic along established access trails. This rose species also blooms from late spring to early fall, then gives rise to a bright red fruit. The pines and junipers which are adapted to sand dunes provide the visual appeal of evergreens in the back dunes. The major function of tree and shrub vegetation on sand dunes is still the permanent solid structural stabilization. All of trees and shrubs of the sand dunes produce viable seed, but intentional establishment occurs using bare-rooted or potted seedlings.

Date = March 15 to April 15; unless soil is frozen

Planting Unit = 1/0 or 2/0 bare-root seedlings or containerized transplants

Depth = 2 inches below the nursery grown depth

Method = hand placement or using a tree planter

Size =  $\geq$  12 inches tall

Spacing = 4 to 6 feet apart; off-set (stagger) rows for maximum protection

Notes: to ensure establishment (first 2 years) all competing vegetation must be removed from within 2 feet of each plant; it

is important not fertilize the surrounding vegetation which will potentially out-compete the tree or shrub

### C. Maintenance

#### 1) Fertilizer

Date = May through July; no sooner than 30 days after planting

Rate =  $\leq$  50 lbs. of nitrogen (N) per acre,  $\leq$  25 lbs. of phosphorus (P) and potassium (K) per acre

Frequency :

- Apply N for the first two years after planting, then as needed to maintain stem density and plant health.
- Single or split applications are acceptable if not applied before May 1 or after July 30. Split applications must be at least 30 days apart.
- It is only necessary to apply P and K bi-annually

Recommended Formulations:

- 10-10-10, 20-10-10, 15-10-10, etc. are acceptable as long as the maximum rates per nutrient are not exceeded
- Time release fertilizers are encouraged that will provide the target amounts of the primary nutrients per acre.

Notes:

- Only apply fertilizer to within the drip line of shrubs and trees. Not following this rule will result in excessive herbaceous growth, which will out compete newly established trees and shrubs.
- Apply using broadcasting machinery

#### 2.) Replant:

- Like a chain, a dune system is no stronger than its weakest link. Uniform, unbroken dune lines are essential to the protection a system can provide.
- Uncontrollable events (i.e. storms, construction, etc.) may damage sand dunes. If such damage occurs between October and April replant within a month. If the damage is experienced from May to September, utilize the outlined sand fencing or excavation procedures listed below, then plant during the recommended establishment period .

2. **SAND FENCING:** A quick and effective way to build temporary sand dunes is with the use of sand fencing (standard snow fence). Utilizing lines of

fencing and wooden posts, orientated parallel to the beach. A source of sand is necessary for this technique to be effective, but it is not limited by time of establishment.

#### A. Materials

##### 1) Fencing:

- Standard 4 ft. slatted wood snow fencing; wood must be decay free
- Four wire ties ( $\geq 12$  ga.) must be used to secure fencing to each post.

##### 2) Posts:

- Wooden posts must be  $\geq 6\frac{1}{2}$  ft. long, with a minimum diameter of 3 inches; typical length ranges from 7 to 8 ft.
- The posts should be made from black locust, eastern red cedar, Atlantic white cedar, or other species of similar durability and strength.
- Space posts 10 ft. apart, and set them  $\geq 3$  feet deep

#### B. Technique

- 1) Position - orientate fence lines parallel to waterline of the beach, at least 140 feet from mean high tide (see figure 2)
- 2) Height - with adequate sand sources, dune elevations can be increased annually by at least four foot increments.  
(approximately the maximum height of the fencing, this can be increased with vegetation); The maximum dune height which is attainable will range from 12 to 15 feet, but is greatly influenced by prevailing wind velocities and sand grain size
- 3) Installation - weave fencing in front of and behind alternating posts to attain maximum strength
- 4) Number of Rows - 2 parallel rows spaced 30 to 40 feet apart, are ideal; but single rows with 30 ft. perpendicular spurs, spaced 40 ft. apart are also acceptable if space is a major limiting factor
- 5) Replacement - sand will typically fill fencing to  $\frac{3}{4}$  of its total height at a maximum; upon reaching maximum fence capacity, additional lines of fence can be added until maximum planned dune height is reached; replace damaged fencing and posts within one month of storm damage to maintain a contiguous dune line

### C. Comments

- This method is more expensive per linear foot than building dunes with vegetation alone, but less expensive than using earth moving machinery to construct dunes.
- Although dune height can be increased faster, it is limited by the fence height and ability to continually add more lines of fencing.
- Planting parallel rows of vegetation on either side of fences is usually more effective than either vegetation or fencing techniques alone.
- When complementing fencing with vegetation, do not plant closer than ten feet and no further than 15 feet from the fence lines. Vegetative strips should be about 20 ft. wide

### 3. MECHANICAL EXCAVATION

- With the use of various earth moving machines temporary, excavated sand dunes are quickly created.
- Since time is required for settling and cohesion to occur, such dunes are often short lived and only provide minimal protection to the public and private resources behind them.
- This method is often useful in the repair of storm damaged sand dunes during the fall and winter months. Any blow-out areas can be quickly filled.
- Front-end loaders of all sizes can be used. Various grading machines are also useful.
- Pumped sand from off shore dredging can be shaped and positioned with machinery