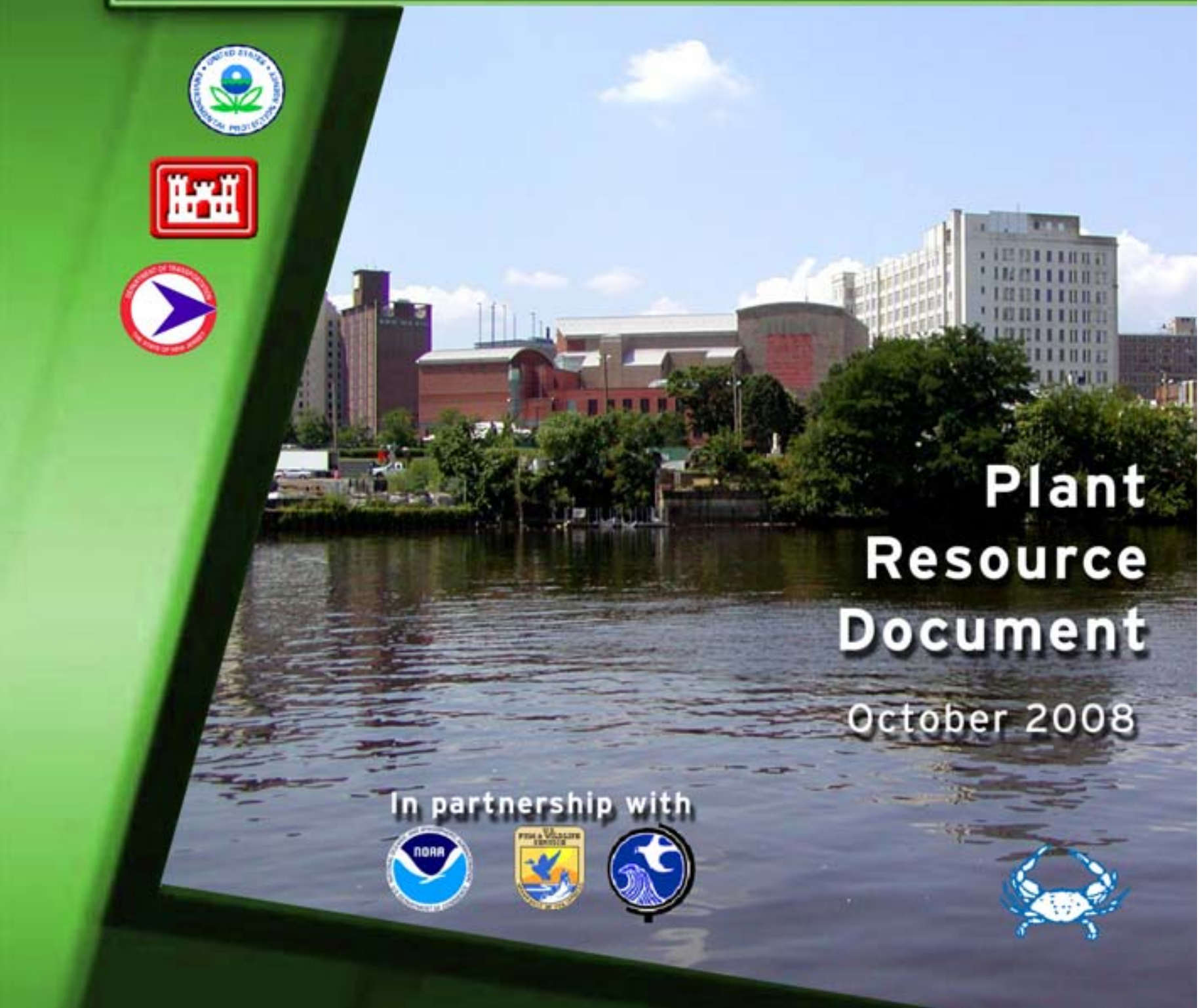
Lower Passaic River Restoration Project



Plant Resource Document

October 2008

In partnership with

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1.0 Introduction

The Lower Passaic River Restoration Project is an integrated remediation and restoration feasibility study of the watershed of the 17-mile, tidally influenced section of the Lower Passaic River from the Dundee Dam to the river mouth in Newark Bay, and its tributaries with confluences south of Dundee Dam within the State of New Jersey. The feasibility study is being conducted through a joint, integrated plan [Water Resources Development Act (WRDA) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)] between the US Army Corps of Engineers - New York District (USACE), the US Environmental Protection Agency, Region 2 (USEPA), and the New Jersey Department of Transportation (NJDOT). The Lower Passaic River Restoration Project is designated an Urban Rivers Restoration Initiative. The Project is being performed in cooperation with New Jersey Department of Environmental Protection (NJDEP), the United States Fish and Wildlife Service (USFWS), and the National Oceanic and Atmospheric Administration (NOAA). These agencies are state and Federal Natural Resource Trustees and Partner Agencies. A Settlement Agreement to conduct the Superfund portion of the Remedial Investigation/Feasibility Study was signed on May 9, 2007 between the USEPA and potential responsible parties referred to as the Cooperating Parties Group (CPG). Per this Settlement Agreement, The CPG has taken responsibility for data collection and study coordination with USEPA oversight.

The purpose of the feasibility study is to recommend a comprehensive watershed-based plan for the restoration and remediation of the Lower Passaic River. This plan will include the identification of restoration opportunities in the Study Area, such as habitat, water quality, and sediment quality improvements, which support broader estuary-wide restoration efforts. Remediation efforts and ecosystem restoration measures will be analyzed together to ensure that the overall solution(s) to the complex problems posed by the contamination in the area are compatible and effectuate the best mix of cost-effectiveness, permanence, and protectiveness. Remediation efforts may include: sediment removal, placement of caps, sediment decontamination *in-situ* or *ex-situ*, and shoreline stabilization. Complimenting restoration goals may include benthic habitat restoration, brackish and freshwater tidal wetland restoration, vegetative buffer creation, shoreline stabilization, and aquatic habitat improvement.

Currently there are two tracks for the CERCLA remedial action: (1) longer-term Remedial Investigation/Feasibility Study (RI/FS) for the full CERCLA study area of 17-miles of the tidally influenced portion of the Lower Passaic River and (2) a shorter-timeframe proposed Source Control Early Action that addresses the lower 8.3 miles of the Lower Passaic River. A Draft Source Control Early Action Focused Feasibility Study report was released for stakeholder review in June 2007. The USEPA is developing a proposed plan for early remedial action for public review and comment. The USACE will be continuing to coordinate the restoration feasibility study along the track of the RI/FS; but is also developing an interim report deliverable as a companion to the early remedial action. The current course of action is to have two interim deliverables (i.e., Focused Ecosystem Restoration Plan (FERP) and a Comprehensive Restoration Plan (CRP)) prior to completing a full feasibility document in 2013.

As restoration opportunities for the tidal Lower Passaic River have been identified, the USACE is proceeding with the FERP by conducting a reach-by-reach study of restoration and public access opportunities for the 17 river miles. Municipality input has already been obtained by the State of New Jersey regarding community plans for waterfront development and an inventory of existing waterfront uses. The USACE is now positioned to develop more detailed plans for viable ecosystem restoration

sites and will be designing restoration alternatives. The Lower Passaic River Plant Restoration Resource Document was developed to provide recommended planting lists for the suite of habitats to be restored in the Lower Passaic WRDA study area. In addition to this Plant Resource Document, multimedia and outreach tools haven been developed that the District will include as part of the FERP. These tools include before and after modules displaying potential restoration opportunities at six locations along the shoreline of the Lower Passaic River. A multimedia CD-ROM containing a virtual tour flyover of the potential restoration sites along the Lower Passaic River was also developed. The CD-ROM focuses on existing restoration sites on the Lower Passaic River, existing municipality plan information, and tributary sites identified in the Restoration Opportunities Report. Also included in the 3-D fly through is a virtual tour of the potential future (30 years from now) for the Newark/Harrison reach.

1.1 Purpose of the Document

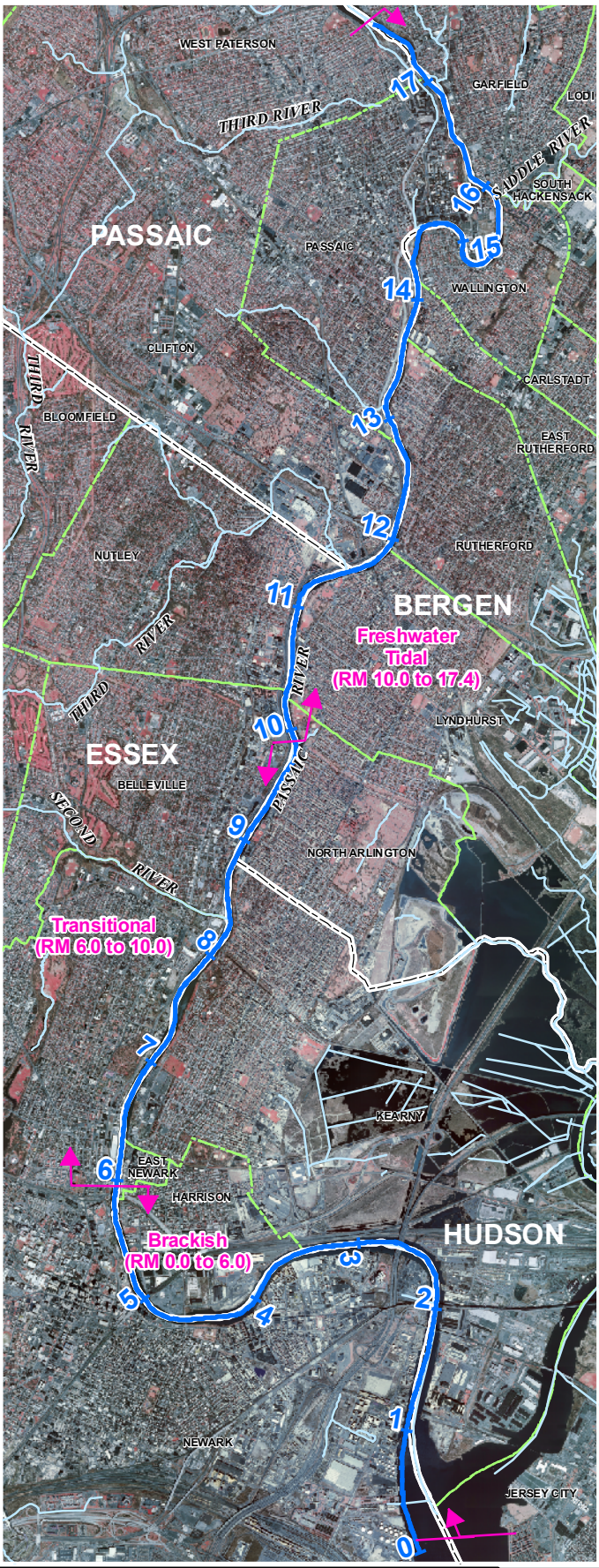
This document provides recommendations for vegetation to be planted or seeded during restoration of the diverse habitats in the WRDA study area including tidal brackish, tidal transitional, tidal freshwater forested, and freshwater forested. Species suitable for tidal and freshwater bioengineering, freshwater forested understory enhancement, and riparian buffer (seeding) are being identified as well. These plant lists were developed utilizing available literature sources, field vegetation sampling data collected in the late fall of 2007 and early spring of 2008, regional native plant nurseries and seed catalogs, as well as professional knowledge of local, native vegetation. Websites such as The PLANTS Database provided by the USDA – NRCS (http://plants.usda.gov) and The Brooklyn Botanical Garden "Where Plants Grow" (http://www.bbg.org/sci/nymf/maps/index.html) were also referred to. The plants' hardiness, salt tolerance, ability to grow at disturbed sites, and dominance against invasive species were all characteristics considered for the recommended plant species. In addition, restoration output and wildlife usage have been considered. Recommendations for trees, shrubs, and grasses and forbs (herbaceous species) for each of the habitat lists are provided, as applicable.

This document also provides information regarding the installation of native plants and where the material can be obtained. Basic planting windows for the recommended regional plant material, as well as specialty windows for salt marsh or aquatic species, are provided as a guide for future restoration plans. Basic information on the removal and control of invasive plant species is also provided.

At the end of each section is a table that lists the scientific and common names of the recommended species for each habitat by strata, as well as their wetland indicator status. In addition, at the end of the document is a master species table containing a comprehensive list of all the recommended plants and the section of the river for which they are recommended.

1.2 Description of River Sections Addressed in this Document

A Conceptual Site Model Report for the Lower Passaic River Restoration Project was developed in conjunction with the USEPA, the USACE, and NJDOT (2007). In this report, the Lower Passaic River is delineated in three river sections – Brackish, Transitional, and Freshwater. A summary of physical and chemical characteristics of each section is provided below. The species chosen for each planting list were selected, in part, based on their ability to tolerate the salinity ranges among the three sections. Figure 1 shows a map of the entire 17-mile restoration area, including the tributaries, and the boundaries of each river section. The following sections provide a general description of the river sections. When planning a restoration effort, more detailed site specific salinity information will need to be collected.



Legend

- 1 — Passaic River Federally Authorized (USACE) Navigation Channel Centerline and Rivermile
- Preliminary River Type Boundaries (Conceptual Site Model, 2007)
- Stream
- Municipality Boundary
- County Boundary

0 3,500 7,000 Feet

Base Map:
NJ Office of Information Technology, 2002.

US Army Corps of Engineers, New York District	Lower Passaic River	October 2008	FIGURE 1

Tidal Brackish River Section

The brackish river section represents the portion of the Lower Passaic River closest to the confluence with Newark Bay where the water salinity is defined as almost always mesohaline (5-18 part per thousand [ppt]) to polyhaline (18-30 ppt). This brackish section of the river has been preliminarily defined as the portion that falls between River Mile 0 and River Mile 6. Water and solids are transported between the brackish river section and Newark Bay primarily as a result of tidal exchange. Dredging of the Lower Passaic River historically created deep channels in the brackish river section, though due to the lack of recent maintenance dredging, these channels have accumulated thick sediment beds dominated by fine-grained material. The brackish river section supports a salt tolerant ecosystem that provides habitat for estuarine aquatic plants, macroinvertebrates, and fish and wildlife species that forage on these prey types.

Tidal Transitional River Section

The transitional section of the river represents the portion of the Lower Passaic River between the freshwater and brackish sections of the river where the salinity values fluctuate under typical tidal conditions. This section of the river is influenced by saltwater intrusion and mixing thus water conditions vary continuously from oligohaline (0.5-5 ppt) to mesohaline. This transitional section of the river has been preliminarily defined as the portion that falls between River Mile 6 and River Mile 10. Water elevations in this section are tidally influenced; therefore, the location of the salt front is constantly migrating within this section. Sediment characteristics in this river section transition from relatively thin, coarse grained sediment beds near the boundary of the freshwater river section to relatively thick, fine-grained sediments near the boundary of the brackish river section. The transitional river section supports a mixture of freshwater and salt-tolerant species.

Tidal Freshwater River Section

The freshwater section of the river represents the portion of the Lower Passaic River where the salinity values are less than 0.5 ppt. This section has been preliminarily defined as the portion of the river that falls between River Mile 10 and River Mile 17.4. Water elevations in this section are tidally influenced; however, the salt front rarely enters this section. Sediments in this river section are primarily coarse-grained material; fine-grained sediment beds are relatively thin due to low sedimentation rates. The freshwater river section supports a freshwater ecosystem which provides habitat for freshwater aquatic plants, macroinvertebrates, and fish and wildlife species that forage on these prey types.

2.0 Native Plant Material

A native species is one that occurs in a particular region, ecosystem, and habitat without direct or indirect human actions. Native species have adapted to the geography, hydrology, and climate of that region and occur in communities that have evolved alongside other plants. As a result, a community of native plants provides habitat for a variety of native wildlife species such as songbirds and butterflies. Species native to North America are generally recognized as those occurring on the continent prior to European settlement. Native plants are valued for their economic, ecological, genetic, and aesthetic benefits.

2.1 Utilizing Native Plants

Using native plants in restoration projects or as a substitute for exotic ornamental plantings can help to reverse the loss of native species diversity and loss of habitat complexity. Although methods may differ,

native plants require the same level of care in installation and establishment as do ornamental plants. If the environment has been altered significantly through human activities, some work will be necessary to recreate an environment more hospitable to natives. However, in the long run, natives will form self-sustaining plant communities that do not require significant maintenance. Because they are adapted to the local climate, they tend to resist damage from freezing, drought, common diseases, and herbivory.

Native plant species provide the keystone elements for ecosystem restoration. As they grow and seed, they help to increase the local population of native plants, providing numerous benefits. There are specific associations of mycorrhizal fungi with plants, invertebrates with woody debris, pollinators with flowers, and birds with structural habitat that can only be rebuilt by planting native plants.

Advantages of native plants include:

- Adding beauty to the landscape and preserving natural heritage;
- Providing food and habitat for native wildlife;
- Decreasing the amount of water needed for landscape maintenance;
- Requiring very little long-term maintenance if they are properly planted and established;
- Producing long root systems to stabilize soil; and
- Protecting water quality by controlling soil erosion and moderating floods and droughts.

2.2 Obtaining Native Plants

Once native plant species are chosen for a restoration project, consideration should be made to the range of the source material that will be purchased. Genetic variations exist within plants of the same species that affect its ability to succeed in various regions of the United States. For example red maple is widely distributed throughout North America extending from Newfoundland to southern Florida. However, attempting to transplant seeds from a red maple growing in southern Florida to northern New Jersey may prove to be unsuccessful due to adaptational differences.

The following is a list of native plant nurseries located within the local range of the Lower Passaic River. Addresses and websites (if available) are provided for each. Effort was taken to produce a complete list, although it is not exhaustive. Any qualifying nurseries reading this document that are not listed may contact Catherine J. Mulvey, Biologist at the USACE – NY District (Catherine.J.Mulvey@usace.army.mil) and to be added to the list. Whether or not a plant species is readily available from a local native plant nursery has been considered prior to the development of a project-specific plant list, but most local nurseries will assist with plant species selection if brought into the project during the development phase. Quantities of high marsh species and tidal shrub species are limited and will need to be contract grown.

Table 1 – Native Plant Nurseries

New Jersey:

Arrowwood Nursery
870 W. Malaga Road, Route 659
Williamstown, NJ 08094

Mapleton Nurseries
140 Mapleton Road
Kingston, NJ 08528
www.mapletonnurseries.com

Earth First Native Plant Nursery
2501 Tilton Road #810
Egg Harbor Twp, NJ 08234

New Jersey Forest Nursery
370 East Veterans Highway
Jackson, NJ 08527
www.njforestrycenter.org

Pinelands Nursery, Inc.
323 Island Road
Columbus, NJ 08022
www.pinelandsnursery.com

Wild Earth Native Plant Nursery
1005 Farmingdale Road
Freehold, NJ 07728

Toadshade Wildflower Farm
53 Everittstown Road
Frenchtown, NJ 08825
www.toadshade.com

USDA's Cape May Plant Materials Center
1536 Route 9 North
Cape May Courthouse, NJ 08210
plant-materials.nrcs.usda.gov/NJPMC

Pennsylvania:

Edge of the Woods Native Plant Nursery
2415 Route 100
Orefield, PA 18069
www.edgeofthewoodsnursery.com

Go Native Tree Farms
2310 Chestnut View Drive
Lancaster, PA 17603
www.gonativetrees.com

Musser Forests, Inc.
1880 Route 119 Hwy N
Indiana, PA 15701
www.musserforests.com

North Creek Nurseries, Inc.
388 North Creek Road
Landenberg, PA 19350
www.northcreeknurseries.com

Redbud Native Plant Nursery, LLC
1214 North Middletown Road
Glen Mills, PA 19342
www.redbudnativeplantnursery.com

Yellow Springs Farm Native Nursery
1165 Yellow Springs Road
Chester Springs, PA 19425
www.yellowspringsfarm.com

Ernst Conservation Seeds
9006 Mercer Pike
Meadville, PA 16335
www.ernstseed.com

Meadowood Native Plant Nursery
24 Meadowood Drive
Hummelstown, PA 17036
www.meadowoodnursery.com

New Moon Nursery
13 Ways Lane
Kennett Square, PA 19348
www.newmoonnursery.com

Octoraro Native Plant Nursery
6126 Street Road
Kirkwood, PA 17536
www.octoraro.com

Sylva Native Nursery & Seed Co.
3815 Roser Road
Glen Rock, PA 17327
www.sylvanative.com

New York:

Native Landscapes Garden Center
991 Route 22
Pawling, NY 12564
www.nativelandscaping.net

Greenbelt Native Plant Center
3808 Victory Boulevard
Staten Island, NY 10314

Maryland:

Environmental Concern, Inc.
PO Box P, 201 Boundary Lane
St. Michaels, MD 21663
www.wetland.org/nursery_home.htm

Massachusetts:

New England Wetland Plants, Inc.
820 West Street
Amherst, MA 01002
www.newp.com

3.0 Biological Benchmarks

Biological benchmarks (biobenchmarks) are typically used as reference points, in conjunction with tidal data, to determine optimal elevation ranges for the establishment of plants in tidal and alluvial wetlands. The long-term success of a restored or created marsh relies primarily on establishing, with a high degree of accuracy, the correct elevations for the different vegetative communities. To determine target elevation ranges, detailed observations of functioning habitats are made and survey data are collected. These observations illustrate the elevations and tidal regimes under which individual species thrive or struggle, and reveal the elevations at which undesirable non-native species begin to out-compete target native species. The biobenchmarks are then compared with the tidal analysis results to determine optimal elevations for the establishment of marsh habitats.

3.1 Brackish River Section

On October 31, 2002, biobenchmark studies of reference wetlands were conducted in the brackish section of the river (near River Mile 4). The sparse patches of smooth cordgrass (*Spartina alterniflora*) within the Proposed Minish Wetland Restoration Site in Newark and the more densely vegetated portions of the Proposed Harrison Wetland Restoration Site across the Passaic River were included as reference wetlands. It should be noted that these smooth cordgrass communities are rare in the Lower Passaic. In general, the banks of the Passaic River in the brackish section consist of bulkheads or unvegetated rock and mud flats. The biobenchmark data included the lowest and highest elevations of both native *Spartina alterniflora* and non-native common reed (*Phragmites australis)* communities.

Wetland vegetation at Minish Site, 2002

Example of wetlands on the Harrison side of the Passaic River near River Mile 4

The elevations of the biobenchmarks were surveyed with reference to the National Geodectic Vertical Datum of 1929 (NGVD29). The results indicate that *Spartina alterniflora* is present on the Newark side of the river from elevation 0.9 to 2.4 feet and on the Harrison side of the river from elevation 1.3 to 3.6 feet. The lowest elevation of *Phragmites* dominance was observed at elevation 3.0 feet.

The USACE had previously developed a conceptual design for the Minish Park Wetland Restoration Project, the site of the Proposed Minish Wetland Restoration Site. Through an analysis of the biobenchmark and tidal data collected at the site, the design elevations and optimal habitat ranges were determined. Low marsh elevations (0.5 to 3.0 ft NGVD29) were set to provide tidal flooding at a duration that will support the establishment of *Spartina alterniflora*, while elevations for the high marsh (3.0 to 4.0 ft) and shrub

marsh (4.0 to 5.0 ft) were set to allow for a tidal flooding duration sufficient to promote the establishment of their particular plant species.

3.2 Transitional River Section


Bio-benchmarks near River Mile 7.7

On May 13, 2008, bio-benchmark studies were conducted along the shoreline of the Lower Passaic River at River Mile 7.7 which is adjacent to Kearny Riverbank Park in Kearny. Bio-benchmark data was collected at locations north and south of River Mile 7.7. The lowest elevation of vegetation growth as well as the elevations where invasive species could be found growing was both measured. Results of the bio-benchmark studies for the northern most sampling point show *Polygonum hydropiperoides* growing from 2.08 – 2.28 feet. Growth of Japanese knotweed began at 2.28 feet and continued to the top of the slope at 11.69 feet. Vegetation was exclusively knotweed from 2.28 – 8.41 feet. The southern most point shows similar vegetation elevations with Japanese knotweed slightly less prominent. *Polygonum hydropiperoides* was measured from 2.10 – 3.76 feet and Japanese knotweed was measured from 3.76 – 11.03 feet. Vegetation was exclusively knotweed from 3.76 – 5.08 feet.

3.3 Freshwater River Section


Bio-benchmarks near River Mile 7.7

Bio-benchmark studies were conducted at two locations within the freshwater portion of the Lower Passaic River. The first location was near River Mile 10.9, a tidal freshwater sampling point. The second location was at Toney's Brook, a tributary of the Second River which represents non-tidal freshwater habitat.

On May 13, 2008, bio-benchmark studies were conducted along the shoreline of the Lower Passaic River at River Mile 10.9 which is adjacent to Riverside Park in Lyndhurst. Bio-benchmark data was collected at two locations near this point and measured lowest elevations of vegetation growth as well as elevations of growth of invasive species. Results of the bio-benchmark studies for the northern most sampling point indicate that the lowest elevation for vegetation growth (*Polygonum hydropiperoides*) occured at 2.37 feet, lower elevations consisted of unvegetated mudflat. Shrub growth occurred from 3.99 – 5.70 feet and included box elder, tree of heaven, and multiflora rose. Growth of garlic mustard began at 5.70 feet and continued until the top of the slope at 6.11 feet where a mowed lawn is maintained.

Results from the southern most bio-benchmark location show *Phragmites australis* growing from its lowest elevation of 1.56 feet to the top of bank at 6.20 feet; vegetation was exclusively *Phragmites australis* from 1.57 – 2.16 feet. Shrub growth occurred from 3.72 – 4.34 feet and included desert false indigo (*Amorpha fruticosa*) and multiflora rose growing with *Phragmites australis*.

On May 13, 2008, bio-benchmark studies of Toney's Brook, a tributary of the Second River which is a tributary of the Passaic River, were conducted. Elevations of the existing toe of slope, bankfull and top of slope were measured on both sides of the stream channel. Data was collected on the elevations where

tree growth begins on either side of the stream. Results of the bio-benchmark studies indicate that the stream edge occurs at 182 feet, stream bankfull occurs between 184 and 186 feet and tree growth along the stream begin at 184 – 187 feet. The data collected may be applied to restoration efforts on tributaries of the Lower Passaic River.

4.0 Recommended Plant Lists

The following section provides recommendations for vegetation to be planted or seeded during restoration of the diverse habitats in the WRDA study area including, tidal brackish, tidal transitional, tidal freshwater forested, and freshwater forested. Species suitable for tidal and freshwater bioengineering, freshwater forested understory enhancement, and riparian buffer (seeding) are identified as well.

4.1 Tidal Brackish Plant List

The Tidal Brackish planting list was created by building upon the existing planting plan for the Minish Park Wetland Restoration Project. Suitable plants for use in restoration projects within the brackish portion of the Lower Passaic River are discussed in the following groups: low marsh, high marsh, tidal shrub marsh, upland slopes and native grasslands (including perennial wildflowers).

Spartina alterniflora. USDA-NCRS Golden Meadows PMC.

In the low marsh (areas flooded twice daily by the tide), vegetation would consist exclusively of smooth cordgrass (*Spartina alterniflora*). When established properly and under applicable conditions, smooth cordgrass has proven to provide significant erosion protection to shorelines, canal banks, and other areas of coastal wetland loss. In addition, smooth cordgrass is an effective soil stabilizer used on interior tidal mudflats, dredge-fill sites, and other areas of loose and unconsolidated soils associated with marsh restoration. It provides an effective buffer that dissipates energy, reduces shoreline scouring, and traps suspended sediments and other solids. Dense stands of smooth cordgrass are efficient users of available nutrients, producing significant amounts of organic matter. The cumulative effects of organic matter production, sediment trapping, and erosion control not only provide shoreline protection but also accelerate sediment accumulation and near-shore building. Consequently, smooth cordgrass is a sustainable and renewable restoration resource, and when properly established and in the appropriate habitat, will persist and has the potential to remain indefinitely.

The high marsh (areas flooded periodically by tidal waters) would be planted with the following grasses and rushes: big cordgrass (*Spartina cynosuroides*), saltmeadow cordgrass (*Spartina patens*), common spike rush (*Distichlis spicata*), Chairmaker's bulrush (*Scirpus americanus*), and saltmeadow rush (*Juncus gerardii*). Big cordgrass is closely associated with smooth cordgrass. Ducks and geese eat their tender new shoots. Saltmeadow cordgrass can also be useful for shoreline protection in tidal marsh restorations. In its natural state on the tidal marshes, dense stands of saltmeadow cordgrass cause suspended solids to settle out of floodwaters and take up available nutrients. Common spike rush is naturally found in salt marshes, providing nesting grounds for birds, fish and larvae of many species of marine invertebrate animals. Chairmaker's bulrush provides cover for many birds and small mammals, as well as food in the form of rhizomes and achenes for muskrat and waterfowl.

Baccharis halimifolia. Jeff McMillian @ USDA-NCRS PLANTS Database

Tidal shrub marsh occurs at elevations above the high marsh and would include eastern baccharis (*Baccharis halimifolia*), bayberry (*Myrica pensylvanica*), and Jesuit's bark (*Iva fructescens*). *Baccharis halimifolia* is highly resistant to salt spray and flooding. Marsh wrens and other small birds frequently nest in the openly branched, brittle stems. This plant is currently being investigated for application in soil bioengineering systems to stabilize tidal shorelines because of its ability to root from dormant, unrooted cuttings. Bayberry is a salt spray tolerant shrub that provides excellent secondary stabilization. Because some leaves remain on the plant throughout most of the winter months, it provides year-round shelter for wildlife. The berries provide a key energy source for swallows migrating south along the mid-Atlantic coast. Bayberry also has the ability to "fix" nitrogen and is an important constituent of re-vegetation efforts. Jesuit's bark is normally associated with the mid to high marsh ecosystem, forming the last line of defense for shoreline erosion control. Jesuit's bark provides suitable nesting habitats for various species of birds, like the red-winged blackbird and the marsh wren.

Juniperus virginiana. Larry Allain @ USDA-NCRS PLANTS Database.

Upland slopes provide an important buffer to the adjacent marsh areas, protecting the marshes from stormwater runoff from development and providing secondary stabilization, erosion control, and wildlife habitat. The following trees and shrubs may be planted: beach plum (*Prunus maratima*), eastern red cedar *(Juniperus virginian*a), winged sumac (*Rhus copallinum*), common hackberry (*Celtis occidentalis*), and inkberry (*Ilex glabra*). Eastern red cedar is widely used in wildlife plantings. The twigs and foliage are eaten extensively by hoofed browsers and provide important protective nesting cover, but the chief attraction to wildlife is the bluish-black berry-like fruit which is eaten by many species of birds and mammals. Winged sumac serves primarily as a winter emergency food for wildlife; roughly 300 species of songbirds include sumac fruit in their diet. Winged sumac is best used on disturbed sites where pioneer species are desirable. Common hackberry is included in windbreak plantings to control wind erosion. Additionally, its deep root system makes it useful for preventing soil erosion on disturbed sites. Small mammals consume the fruit, which persist throughout the winter. Inkberry is often used for erosion control and watershed protection. The shrub provides cover for white-tailed deer, small rodents, and several species of birds, while its fruit is eaten by at least 15 species of birds and the flower nectar is an important source for honey production.

Schizachyrium scoparium. J.S. Peterson @ USDA-NRCS PLANTS Database

Upland coastal grassland areas (including perennial wildflowers) would be planted with a native grass seed mix. The recommended mix mirrors what was developed for the Minish Park Wetland Restoration Project. Grass species include: little bluestem (*Schizachyrium scoparius*), big bluestem (*Andropogon gerardii*), switchgrass (*Panicum virgatum*), side-oats grama (*Bouteloua curtipendula*), and Italian ryegrass (*Lolium multiflorum*). Switchgrass is a highly valuable native grass for use on a wide range of sites. It is a valuable soil stabilization plant on strip-mine spoils, sand dunes, dikes, and other critical areas, provides excellent nesting and fall and winter cover for pheasants, quail, song birds and rabbits. Side-oats grama is recommended in grass mixtures for range and pasture seeding, for earth fill and bank stabilization, and for other critical areas and recreational plantings. Italian

ryegrass is primarily used for quick cover in erosion control plantings.

The perennial wildflowers contained in the native grass seed mix include butterfly milkweed (*Asclepias tuberosa*), New England aster (*Aster prenanthoides*), crooked-stem aster (*Aster nove-angliae*), New York aster (*Aster novi-belgii*), scarlet Indian paintbrush (*Castilleja coccinea*), oxeye daisy (*Leucanthemum vulgare*), lance-leaved tickseed(*Coreopsis lanceolata*), blue mistflower (*Conoclinium coelestinum*), ox-eyed sunflower (*Heliopsis helianthoides*), perennial lupine (*Lupinus perennis*), showy evening primrose (*Oenothera speciosa*), beardtongue (*Penstemon digitalis*), fall phlox (*Phlox paniculata*), black-eyed Susan (*Rudbekia hirta*), brown-eyed Susan (*Rudbekia triloba*), and early goldenrod *(Solidago juncea*).

The following conceptual diagram was created to show potential restoration opportunities along the Lower Passaic River. This particular diagram is displaying the shoreline along Joseph G. Minish Park. It has been included to provide an example of the elevations along the shoreline where the vegetation discussed above may be planted:

Figure 2 – Conceptual Brackish Planting Schematic

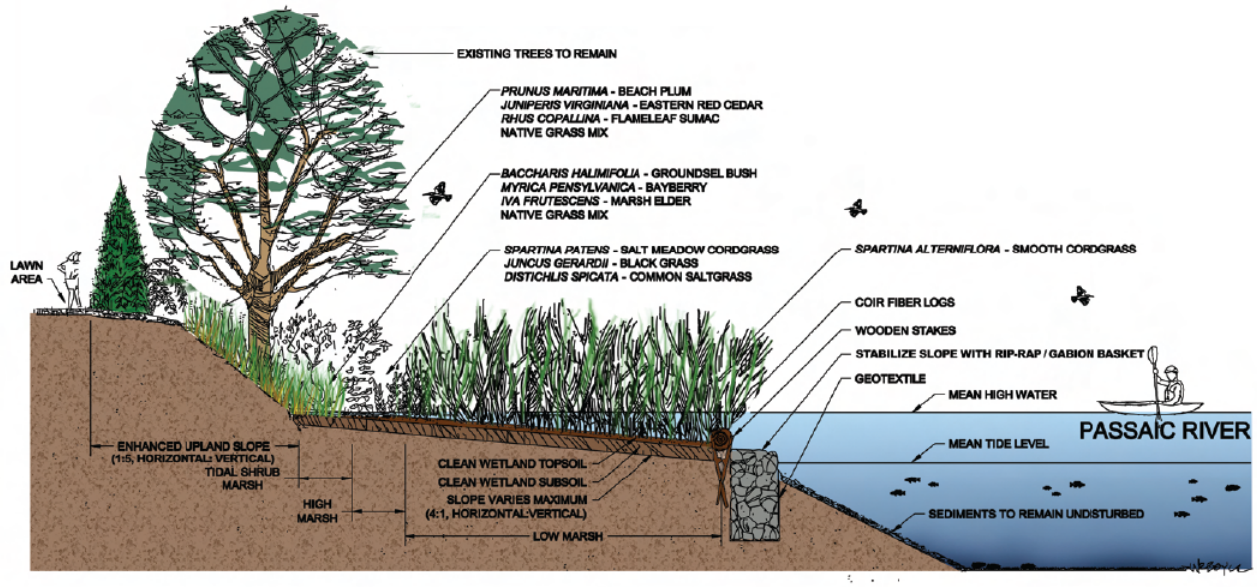


Table 2 – Tidal Brackish Plant List			
Trees and Shrubs			
Scientific Name	**Common Name**	***Wetland Indicator Status**	**^Planting Zone**
Aronia arbutifolia	Red chokeberry	FACW	TS
Baccharis halimifolia	Eastern baccharis	FACW	TS
Celtis occidentalis	Common hackberry	FACU	US
Ilex glabra	Inkberry	FACW-	TS
Iva fructescens	Jesuit's bark	FACW+	US
Juniperus virginiana	Eastern red cedar	FACU	TS
Myrica pensylvanica	Bayberry	FAC	US
Prunus maritima	Beach plum	NL	US
Rhus copallinum	Winged sumac	NI	US
Grasses, Sedges and Rushes			
Andropogon gerardii	Big bluestem	FAC	NG
Bouteloua curtipendula	Side-oats grama	NL	NG
Distichilis spicata	Saltgrass	FACW+	HM
Juncus gerardii	Saltmeadow rush	FACW+	HM
Panicum virgatum	Switchgrass	FAC	NG
Schizachyrium scoparius	Little bluestem	FACU-	NG
Scirpus (Schoenoplectus) americanus	Chairmaker's bulrush	OBL	HM
Spartina alternifolia	Smooth cordgrass	OBL	LM
Spartina cynosuroides	Big cordgrass	OBL	HM
Spartina patens	Saltmeadow cordgrass	FACW+	HM
Forbs			
Asclepias tuberosa	Butterfly milkweed	NL	NG
Aster prenanthoides	Crooked-stem aster	FAC	NG
Aster nove-angliae	New England aster	FACW-	NG
Aster novi-belgii	New York aster	FACW+	NG
Aster tenuifolius	Perennial saltmarsh aster	OBL	HM
Castilleja coccinea	Scarlet Indian paintbrush	FAC	NG
Conoclinium coelstinum	Blue mistflower	FAC	NG
Coreopsis lanceolata	Lance-leaved tickseed	FACU	NG
Heliopsis helianthoides	Ox-eyed sunflower	NL	NG
Leucanthemum vulgare	Oxeye daisy	NL	NG
Lupinus perennis	Perennial lupine	NL	NG
Oenothera speciosa	Showy evening primrose	NL	NG
Penstemon digitalis	Beardtongue	FAC	NG
Phlox paniculata	Fall phlox	FACU	NG
Rudbekia hirta	Black-eyed Susan	FACU-	NG
Rudbekia triloba	Brown-eyed Susan	FACU	NG

Sagittaria graminea	Grass-leaved arrowhead	OBL	HM
Samolus floribundus	Water pimpernel	OBL	HM
Solidago elliotii	Coastal swamp goldenrod	OBL	HM
Solidago juncea	Early goldenrod	NL	NG
Solidago sempervirens	Seaside goldenrod	FACW	HM

*** Key to indicator categories:**

OBL: Obligate Wetland, occur almost always (estimated probability >99%) under natural conditions in wetlands
FACW: Facultative Wetland, usually occur in wetlands (estimated probability 67%-99%), but occasionally found in non wetlands
FAC: Facultative, equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%)
FACU: Facultative Upland, usually occur in non-wetlands (estimated probability 67%-99%), but occasionally found in wetlands (estimated probability 1%-33%)
NL: Not found on national listings of plants occurring in wetlands

A positive (+) sign following and indicator indicates a frequency toward the higher end of the category.
A negative (-) sign following and indicator indicates a frequency toward the lower end of the category.

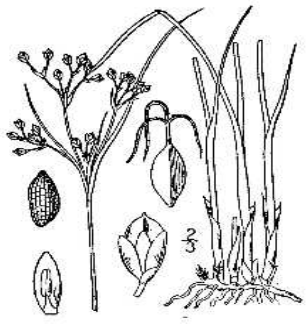
Sources: 1996 National List of Vascular Plant Species that Occur in Wetlands. (All Regions). U.S. Fish and Wildlife Service, March 1997.
1995 Supplement to the List of Plant Species that Occur in Wetlands: Northeast (Region 1). U.S. Fish and Wildlife Service, August 1995.

^LM=Low Marsh, HM=High Marsh, TS=Tidal Shrub, US=Upland Slope, NG=Native Grassland

4.2 Tidal Transitional Plant List

The following trees and shrubs are suitable for planting in the tidal transitional portion of the Lower Passaic River: eastern baccharis (*Baccharis halimifolia*), common buttonbush (*Cephalanthus occidentalis*), coastal sweet pepperbush (*Clethra alnifolia*), Inkberry (*Ilex glabra*), bayberry (*Myrica pensylvanica*), sweetbay (*Magnolia virginiana*), and sweet gum (*Liquidambar styraciflua*). These species will persistent in an environment that fluctuates from nearly fresh water to water that is mesohaline. The wildlife benefits of bayberry, eastern baccharis, and coastal sweet pepperbush are discussed in the previous section.

Cephalanthus occidentalis. USDA-NRCS PLANTS Database



Juncus gerardii. USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown

On the upland slope of the marsh area the following trees and shrubs would be planted to provide secondary stabilization, erosion control, and wildlife habitat: winged sumac (*Rhus copallinum*), hackberry (*Celtis occidentalis*), black cherry (*Prunus serotina*) and eastern red cedar (*Juniperus virginiana*). These recommended upland species include some of those suggested for planting in the brackish portion of the river. Information about hackberry, eastern red cedar, winged sumac and inkberry in provided in the previous section. The fruits of black cherry are important food for numerous species of passerine birds, game birds, and mammals.

Grasses, sedges, and rushes that would be utilized for marsh planting in the transitional portion of the Lower Passaic River and portions of the Second River that may also have low salinity levels include: saltmarsh rush (*Juncus gerardii*), switchgrass (*Panicum virgatum*), hardstem bulrush (*Scirpus*

(*Schoenoplectus*) *acutus*), Chairmaker's bulrush (*Scirpus* (*Schoenoplectus*) *americanus*), softstem bulrush (*Scirpus* (*Schoenoplectus*) *tabernaemontani*), big cordgrass (*Spartina cynosuroides*), and prairie cordgrass (*Spartina pectinata*). The values of planting switchgrass and big cordgrass in a restoration area are discussed in the previous section. The stiff stems, vigorous rhizomes and robust size of prairie cordgrass are useful in stabilizing soil, providing streambank stabilization, and providing wildlife habitat and cover. The dense root mass of hardstem bulrush makes it an excellent choice for soil stabilization. The above ground biomass of this species will also provide protection from stream currents that can erode streambanks. Softstem bulrush, Chairmaker's bulrush, and saltmarsh rush all provide forage, protection, and nesting habitat for small mammals, water fowl, and wading birds.

Aster novi-belgii. William S. Justice @ USDA-NRCS PLANTS Database

Forbs species that would be planted in the transitional portion of the river that will provide additional soil and sediment stabilization include: New York aster (*Aster novi-belgii*), perennial saltmarsh aster (*Aster tenuifolius*), grass-leaved goldenrod (*Euthamia graminifolia*), seaside goldenrod (*Solidago sempervirens*) marsh hibiscus (*Hibiscus moscheutos*), sweetflag (*Acornus americanus*), green arrow arum (*Peltandra virginica*), and pickerelweed (*Pontederia cordata*).

The following conceptual diagram was created to show potential restoration opportunities along the Lower Passaic River. This particular diagram is displaying the shoreline adjacent to the Kearny boat ramp. It has been included to provide an example of the elevations along the shoreline where the vegetation discussed above may be planted:

Figure 3 – Conceptual Transitional Planting Schematic

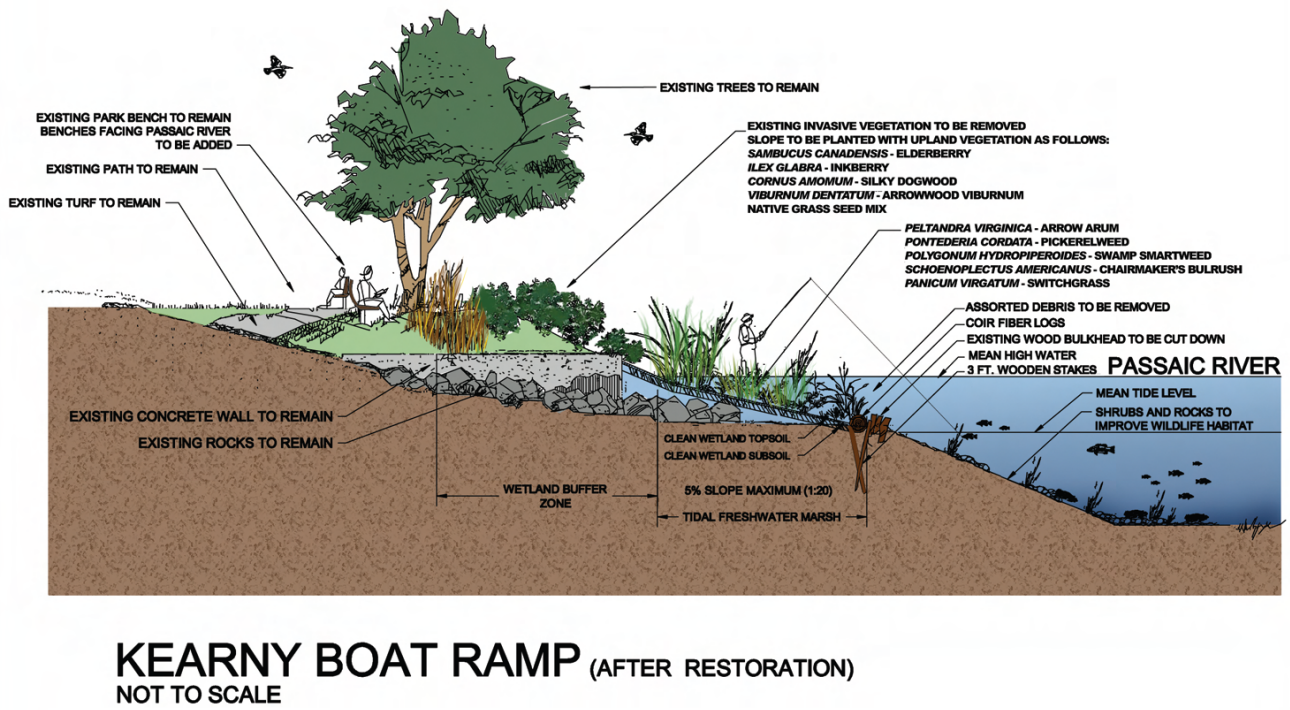


Table 3 – Tidal Transitional Plant List		
Trees and Shrubs		
Scientific Name	**Common Name**	**Wetland Indicator Status**
Baccharis halimifolia	Eastern baccharis	FACW
Celtis occidentalis	Hackberry	FACU
Cephalanthus occidentalis	Common buttonbush	OBL
Clethra alnifolia	Sweet pepperbush	FAC+
Ilex glabra	Inkberry	FACW-
Juniperus virginiana	Eastern red cedar	FACU
Liquidambar styraciflua	Sweetgum	FAC
Magnolia virginiana	Sweetbay	FACW+
Myrica pensylvanica	Bayberry	FAC
Prunus serotina	Black cherry	FACU
Rhus copallinum	Winged sumac	NI
Grasses, Sedges and Rushes		
Juncus gerardii	Saltmeadow rush	FACW+
Panicum virgatum	Switchgrass	FAC
Scirpus (Schoenoplectus) acutus	Hardstem Bulrush	OBL
Scirpus (Schoenoplectus) americanus	Chairmaker's bulrush	FACW+
Scirpus tabernaemontani	Softstem Bulrush	OBL
Spartina cynosuroides	Big cordgrass	OBL
Spartina pectinata	Prairie cordgrass	OBL
Acorus americanus	Sweetflag	OBL
Aster novi-belgii	New York aster	FACW+
Aster tenuifolius	Perennial saltmarsh aster	OBL
Forbs		
Euthamia graminifolia	Grass-leaved goldenrod	FAC
Hibiscus moscheutos	Marsh hibiscus	OBL
Peltandra virginica	Green arrow arum	OBL
Pontederia cordata	Pickerelweed	OBL
Solidago sempervirens	Seaside goldenrod	FACW

4.3 Tidal Freshwater Forested Plant List

Acer rubrum. Kenneth J. Sytsma @ University of Wisconsin, Madison.

Tree Species:

The following trees are suitable for planting in the tidal freshwater portion of the Lower Passaic River and its tributarues: red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*) green ash (*Fraxinus pennsylvanica*), black willow (*Salix nigra*) and blackgum or black tupelo (*Nyssa sylvatica*). Red maple is one of the easiest trees to grow, can be planted at many types of disturbed sites for rehabilitation projects, will establish quickly and grow

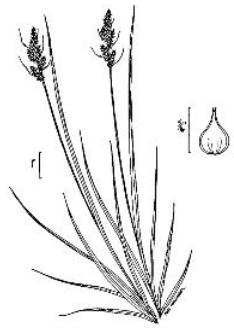
rapidly and is abundantly available from local nurseries. Sweet gum is a hardy shade tree with brilliant fall foliage well adapted to moist or wet woods, tidal swamps, and along streambanks. Its seeds provide food for goldfinches, mallard ducks, Carolina chickadees, yellow-bellied sapsuckers, squirrels, and chipmunks. Blackgum establishes well in erosion prone areas and the fruit provides food for woodpeckers, mockingbirds, brown thrashers, thrushes, flickers, and starlings.

Shrub Species:

Spiraea latifolia. USDA-NRCS PLANTS Database

Shrub species that would be planted in the understory of the trees discussed above and will provide high quality wildlife habitat include common buttonbush (*Cephalanthus occidentalis*), silky dogwood (*Cornus amomum*), American black elderberry (*Sambucus canadensis*), inkberry (*Ilex glabra*), speckled alder (*Alnus rugosa*), meadowsweet (*Spiraea latifolia*), desert false indigo (*Amorpha fruticosa*), southern arrowwood (*Viburnum dentatum*) and nannyberry (*Viburnum lentago*). Waterfowl and shorebirds consume the seeds of common buttonbush and it can also be used for erosion control along shorelines because it forms dense stands and its swollen plant base stabilizes the plant. The *Viburnum* spp. are shade-tolerant, useful in landscape planting as windbreaks, and produce clusters of flowers and fruits that attract many species of birds and wildlife. Game birds, squirrels and other rodents, and several browsing mammals feed on the fruit and foliage of American black elderberry. The elderberries are also important sources of summer food for many kinds of songbirds.

Herbaceous Species:



Carex vulpinoidea. USDA-NRCS PLANTS Database

Herbaceous species that would provide ground cover in the tidal freshwater forested portions of the Lower Passaic River include perennial grasses, sedges and rushes such as annual wildrice (*Zizania aquatica*), Deertongue (*Dichanthelium clandestium*), shallow sedge (*Carex lurida*), broom sedge *(Carex scoparia*), fox sedge (*Carex vulpinoidea*), straw-colored flatsedge (*Cyperus strigosus*), soft rush (*Juncus effuses*), poverty rush (*Juncus tenuis*), common spikerush (*Eleocharis palustris*), hardstem bulrush (*Scirpus (Schoenoplectus) acutus*), and Chairmaker's bulrush (*Scirpus (Schoenoplectus) americanus*). These herbaceous species, along with some forbs such as crowned beggarticks (*Bidens coronata*) and marsh hibiscus (*Hibiscus moscheutos*), provide protection against surface erosion by binding and restraining soil particles. The majority of these species are available as 2" or 3" plugs or quart size plants from a native plant nursery. Some nurseries (e.g. Pinelands Nursery in Columbus, NJ) also offer a pre-made wetland seed mix available that would be appropriate for freshwater applications. Wetland seed mix may contain the following species: fox sedge (*Carex vulpinoidea*), shallow sedge (*Carex lurida*), soft rush (*Juncus effusus*), green bulrush (*Scirpus atrovirens*), woolgrass (*Scirpus cyperinus*), Virginia wildrye (*Elymus virginicus*), fowl mannagrass (*Glyceria striata*), blue vervain (*Verbena hastata*), blue flag (*Iris versicolor*), New York ironweed (*Vernonia noveboracensis*), swamp milkweed (*Asclepias incarnata*), and grass-leaved goldenrod (*Euthamia graminifolia*).

Peltandra virginica. Tom Shinskey, 2008.

Aquatic Emergent Plant Species:

Aquatic emergent plants provide protection to woody streambanks from wave action as well as food and shelter for many wading and water birds, fish, and aquatic invertebrates. The following species can be planted in the freshwater tidal portions of the Lower Passaic River

and its tributaries: yellow pond-lily (*Nuphar lutea*), green arrow arum (*Peltandra virginica*), pickerelweed (*Pontederia cordata*), duck potato (*Sagittaria latifolia*), halberd-leaf tearthumb (*Polygonum arifolium*), swamp smartweed (*Polygonum hydropiperoides*), arrow-leaf tearthumb (*Polygonum sagittatum*), blue flag (*Iris versicolor*), and water plantain (*Alisma plantago-aquatica*). The leaves and stems of arrow arum, blue flag and pickerelweed create a wave deflecting barrier while the masses knit together and stabilize the submerged sediments. The seeds and/or tubers of pickerelweed, duck potato, and water plantain are valuable food for land birds and water fowl.

Table 4 – Tidal Freshwater Forested Planting List		
Trees and Shrubs		
Scientific Name	**Common Name**	**Wetland Indicator Status**
Acer rubrum	Red maple	FAC
Alnus rugosa	Speckled alder	FACW+
Amorpha fruticosa	Desert false indigo	FACW
Cephalanthus occidentalis	Buttonbush	OBL
Cornus amomum	Silky dogwood	FACW
Fraxinus pennsylvanica	Green ash	FACW
Ilex glabra	Inkberry	FACW-
Liquidambar styraciflua	Sweetgum	FAC
Nyssa sylatica	Blackgum or Black tupelo	FAC
Salix nigra	Black willow	FACW+
Sambucus canadensis	Elderberry	FACW
Spiraea latifolia	Meadowsweet	FACW+
Sambucus canadensis	American black elderberry	FACW-
Viburnum dentatum	Southern arrowwood	FAC
Viburnum lentago	Nannyberry	FAC
Grasses, Sedges and Rushes		
Carex lurida[+]	Shallow sedge	OBL
Carex scoparia	Broom sedge	FACW
Carex vulpinoidea[+]	Fox sedge	OBL
Cyperus strigosus	Strawcolored flatsedge	FACW
Dichanthelium clandestinum	Deertongue	FAC+
Eleocharis palustris	Common spikerush	OBL
Elymus virginicus[+]	Virginia wildrye	FACW-
Glyceria striata[+]	Fowl mannagrass	OBL
Juncus effuses[+]	Soft rush	FACW+
Juncus tenuis	Poverty rush	FAC-
Scirpus (Schoenoplectus) acutus	Hardstem bulrush	OBL
Scirpus atrovirens[+]	Green bulrush	OBL
Scirpus cyperinus[+]	Woolgrass	FACW+
Scirpus (Schoenoplectus) americanus	Chairmaker’s bulrush	FACW+

Zizania aquatica	Annual wildrice	OBL
Forbs		
Alisma plantago-aquatica	Water plantain	OBL
Asclepias incarnate[+]	Swamp milkweed	OBL
Bidens coronata	Crowned beggarticks	OBL
Euthamia graminifolia[+]	Grass-leaved goldenrod	FAC
Hibiscus moscheutos	Swamp hibiscus	OBL
Iris versicolor[+]	Blue flag	OBL
Nuphar lutea	Yellow pond-lily	OBL
Peltandra virginica	Green arrow arum	OBL
Polygonum arifolium	Halberd-leaved tearthumb	OBL
Polygonum hydropiperoides	Swamp smartweed	OBL
Polygonum sagitatum	Arrow-leaved tearthumb	OBL
Pontederia cordata	Pickerelweed	OBL
Rumex verticillatus	Swamp dock	OBL
Sagittaria latifolia	Duck potato	OBL
Verbena hastata[+]	Blue vervain	FACW+
Vernonia noveboracensis[+]	New York ironweed	FACW+

[+]Indicates species included in the wetland seed mix from Pinelands Nursery and are provided as an example of available species.

4.4 Non-tidal Freshwater Forested Plant List

Tree Species:

The following trees are suitable for planting in the non-tidal freshwater forested portion of the tributaries to the Lower Passaic River: red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), sweetgum (*Liquidambar styraciflua*), blackgum (*Nyssa sylatica*), sycamore (*Platanus occidentalis*), swamp white oak (*Quercus bicolor*), pin oak (*Quercus palustris*), and black willow (*Salix nigra*). Most of these plant species are also suitable for planting in the freshwater tidal portion of the Lower Passaic River; the benefits to planning them at a restoration site have been discussed in the previous section. The *Quercus* spp. species adapt to fluctuating moisture levels in the soil, the acorns are an important food for wildlife such as ducks, squirrels and white-tailed deer, and are known for their attractive fall foliage. Green ash is often planted as a shade tree in recreational areas; its winged seeds are eaten by a number of birds and mammals.

Shrub Species:

Shrubs that can be planted in the understory of the trees discussed above and will provide high quality wildlife habitat include: silky dogwood (*Cornus amomum*), American hornbeam (*Carpinus caroliniana*), highbush blueberry (*Vaccinium corymbosum*), sweetbay (*Magnolia virginiana*), spicebush (*Lindera benzoin*), swamp rose (*Rosa palustris*), coastal sweet pepperbush (*Clethra alnifolia*), inkberry (*Ilex glabra*), southern arrowwood (*Viburnum dentatum*), and nannyberry (*Viburnum lentago*). Coastal sweet pepperbush spreads by sending up new shoots forming a thicket of low bushes; this growth form provides moderate erosion control along streams. The fragrant white flowers and nectar of coastal sweet pepperbush attract hummingbirds and butterflies and birds eat its fruit. Over twenty species of birds as well as

Rosa palustris. Robert H. Mohlenbrock @ USDA-NRCS PLANTS Database

rabbits and raccoons browse the leaves and fruit of spicebush. It is a good choice for planting in shady locations but can also grow in full sun. Fruits of highbush blueberry provide important summer and early fall food for numerous species of songbirds and mammals.

Herbaceous Species:
Herbaceous species that would provide ground cover in a restored freshwater forested wetland include perennial grasses, sedges and rushes. Applicable species include: fringed sedge (*Carex crinita*), tussock sedge (*Carex stricta*), fox sedge (*Carex vulpinoidea*), wood reedgrass (*Cinna arundinacea*), Virginia wildrye (*Elymus virginicus*), fowl mannagrass (*Glyceria striata*), and soft rush (*Juncus effuses*). Fowl mannagrass is a rapidly establishing native species suitable for restoration where an herbaceous understory is desired. It improves soil stability and the seeds are food waterfowl while the tall stems and foliage provide good wildlife cover. Fox sedge is a clumping grass that will naturalize where planted. It is an excellent colonizer of the freshwater forested portions of wetland mitigation sites.

Other herbaceous plants that can be found in regional forested wetlands and are recommended for the freshwater forested portion of the Lower Passaic include forbs such as New England aster (*Aster novae-angliae*), New York aster (*Aster novi-belgii*), jewelweed (*Impatiens capensis*), cardinalflower (*Lobelia cardinals*), sensitive fern (*Onoclea sensibilis*), royal fern (*Osmunda regalis*), and lizard's tail (*Saururus cernuus*).

Table 5 – Non-tidal Freshwater Forested Plant List

Trees and Shrubs		
Scientific Name	**Common Name**	**Wetland Indicator Status**
Acer rubrum	Red maple	FAC
Carpinus caroliniana	American hornbeam	FAC
Clethra alnifolia	Sweet pepperbush	FAC+
Cornus amomum	Silky dogwood	FACW
Fraxinus pennsylvanica	Green ash	FACW
Ilex glabra	Inkberry	FACW-
Lindera benzoína	Spicebush	FACW-
Liquidambar styraciflua	Sweetgum	FAC
Magnolia virginiana	Sweetbay	FACW+
Nyssa sylatica	Black gum	FAC
Platanus occidentalis	Sycamore	FACW-
Quercus bicolor	Swamp white oak	FACW+
Quercus palustris	Pin oak	FACW
Rosa palustris	Swamp rose	OBL
Salix nigra	Black willow	FACW+
Vaccinium corymbosum	Highbush blueberry	FACW-
Viburnum dentatum	Southern arrowwood	FAC
Viburnum lentago	Nannyberry	FAC
Grasses, Sedges and Rushes		
Carex crinita	Fringed sedge	OBL

Carex stricta	Tussock sedge	OBL
Carex vulpinoidea	Fox sedge	OBL
Cinna arundinacea	Wood reedgrass	FACW+
Elymus virginicus	Virginia wildrye	FACW-
Glyceria striata	Fowl mannagrass	OBL
Juncus effusus	Soft rush	FACW+
Forbs		
Aster novae-angliae	New England aster	FACW-
Aster *novi-belgii*	New York aster	FACW+
Impatiens capensis	Jewelweed	FACW
Lobelia cardinals	Cardinalflower	FACW+
Onoclea sensibilis	Sensitive fern	FACW
Osmunda regalis	Royal fern	OBL
Saururus cernuus	Lizard's tail	OBL

4.5 Freshwater and Tidal Bioengineering

Streambank and shoreline protection consists of restoring and strengthening banks of streams, lakes and estuaries against scour and erosion by using vegetative plantings, soil bioengineering, and structural systems made from natural materials. These systems can be used alone or in combination. For the purpose of this document, vegetative plantings and several soil bioengineering systems that are applicable to the Lower Passaic River and its tributaries will be discussed in more detail. Information on structural measures used in streambank protection projects (e.g. tree revetment and vegetated geogrids) can be found in Chapter 16 of the *Engineer Field Handbook – Streambank and Shoreline Protection* produced by the United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS). Structural methods are also summarized in *Hudson River Shoreline Restoration Alternatives Analysis* prepared by Alden Research Laboratory, Inc. and ASA Analysis & Communications, Inc. Many of these structural measures are stocked at some of the native plant nurseries discussed in Section 2.2.

Andropogon gerardii. Jennifer Anderson @ USDA-NRCS PLANTS Database

Pontederia cordata. William S. Justice @ USDA-NRCS PLANTS Database

Vegetative Plantings

Vegetative plantings provide benefits to fish and wildlife populations as well as increasing a streambank's resistance to erosive forces. Vegetation near the stream channel provides shade to help maintain suitable water temperature for fish, provides habitat for wildlife, and contributes to aesthetic quality. Leaves, twigs, and insects feeding on the vegetation drop into the stream and provide nutrients for aquatic life.

Herbaceous vegetation (grasses and forbs) offers long-term protection against water and wind erosion on slopes though they provide only minor protection against shallow mass movement. Shallow mass movement describes the geomorphic process by which soil and rock move down slope

under the force of gravity. Herbaceous vegetation helps to prevent surface erosion by reducing sediment transport; retarding velocity of runoff; and enhancing and maintaining infiltration capacity. Herbaceous species are almost always used in conjunction with soil bioengineering projects to add protection against surface erosion. Native perennial grasses and forbs should be used rather than annual grasses. The following perennial grass species would be suitable for providing soil stabilization in freshwater portion of the Lower Passaic River: switchgrass (*Panicum virgatum*), little bluestem (*Schizachyrium scoparium*), Virginia wildrye (*Elymus virginicus*), and big bluestem (*Andropogon gerardii*). Swtichgrass and big bluestem are highly valuable native species suitable for providing soil stabilization on a wide range of sites. The growth habitat of little bluestem, as well as its adaptability to a wide range of soil conditions, makes it a useful component of revegetation mixes, although it is more suitable for using in the upland portions of the stabilization site.

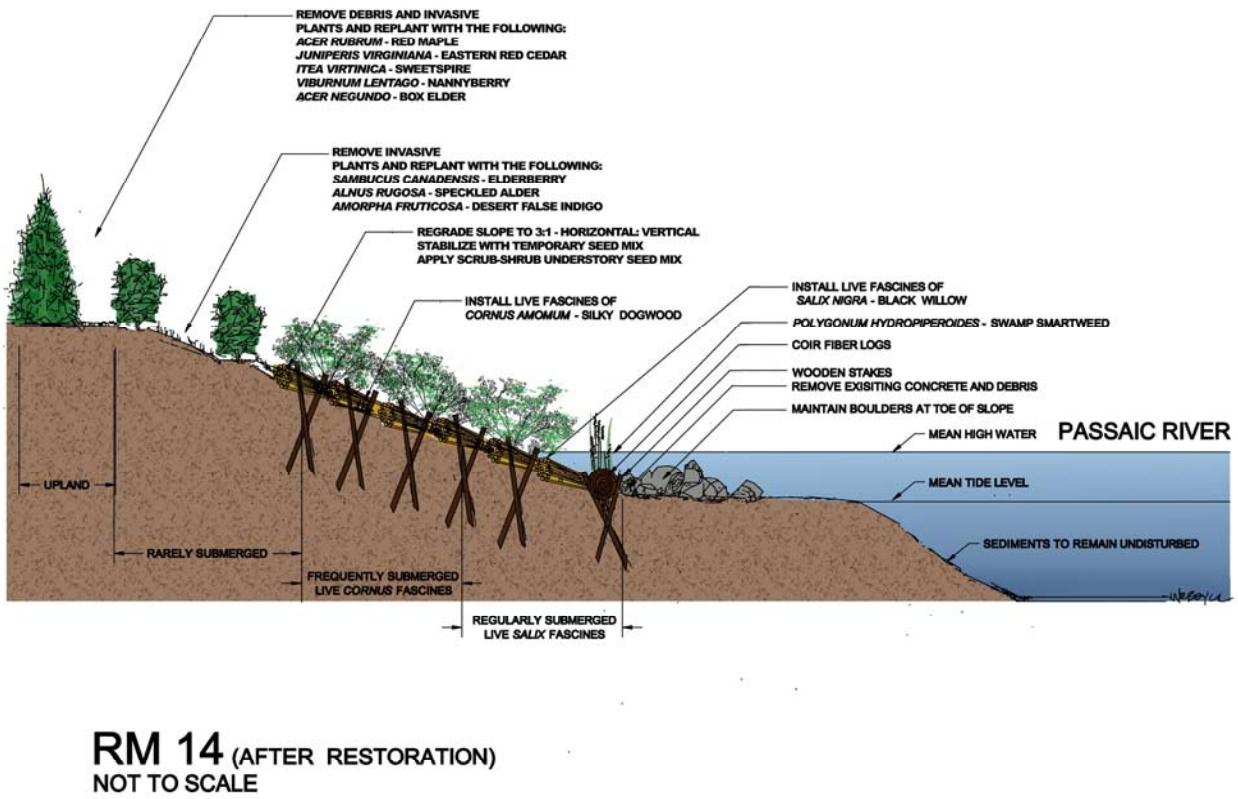
Associated emergent aquatic plants serve multiple functions, including the protection of woody streambank from wave action, which tend to undercut the banks. Suitable emergent aquatic species include green arrow arum (*Peltandra virginica*), pickerelweed (*Pontederia cordata*), and blue flag (*Iris versicolor*).

More deeply rooted woody vegetation provides greater protection against shallow mass movement by mechanically reinforcing the soil with roots; depleting soil water through transpiration; and buttressing and soil arching action from embedded stems. Many species of plants are suitable for streambank protection. The use of locally collected native species should be the first priority. Locally available erosion-resistant species that are suited to the soil, moisture, and climatic conditions of the site are desirable. Native early successional stage willows, dogwoods, and viburnums that will root readily can be planted on streambanks to provide stabilization. Black willow (*Salix nigra*) and pussy willow (*Salix discolor*) as well as silky dogwood (*Cornus amomum*) and red osier dogwood (*Cornus sericea*) are all readily available from native plant nurseries within the state. Indigobush (*Amorpha fruticosa*) is a native, deciduous shrub that was observed growing successfully along the shoreline of Riverbank Park in Lyndhurst Township. The shrub has an extensive root system and is also fairly wind tolerant so it can be planted as a windbreak and also to prevent soil erosion. Speckled alder (*Alnus rugosa*) tolerates a wide variety of soil types, which makes it a good choice for disturbed site rehabilitation and a valuable species to plant along stream banks for erosion control. The root nodules of alders support nitrogen-fixing bacteria, which can enhance the production of woody vegetation grown in association with speckled alder. The quick growth habitat and fibrous root system of boxelder (*Acer negundo*) make it valuable for erosion control. However, the species is short lived and disease prone so it may be used to temporarily stabilize the soil until it is replaced by slower growing but longer lasting trees. American sycamore (*Platanus occidentalis*) is a good choice for planting where a large, fast-growing tree is desired. It is useful in rehabilitation of various sites with saturated soils and is often a natural early colonizer of disturbed sites such as streambanks degraded by channelization.

Amorpha fruticosa. Jennifer Anderson @ USDA-NRCS PLANTS Database

The following conceptual diagram was created to show potential restoration opportunities along the Lower Passaic River. This particular diagram is displaying the shoreline locate at approximately River Mile 14 where it is degraded and in need of stabilization. It has been included to provide an example of the elevations along the shoreline where the vegetation discussed above may be planted:

Figure 4 – Conceptual Freshwater Bioengineering Planting Schematic



RM 14 (AFTER RESTORATION)
NOT TO SCALE

Table 6 – Freshwater and Tidal Bioengineering Plant List		
Trees and Shrubs		
Scientific Name	**Common Name**	**Wetland Indicator Status**
Acer negundo	Boxelder	FAC+
Alnus rugosa	Speckled alder	FACW+
Amorpha fruticosa	Indigobush	FACW
Cornus amomum	Silky dogwood	FACW
Cornus sericea	Red-osier dogwood	FACW+
Platanus occidentalis	Sycamore	FACW-
Salix discolor	Pussy willow	FACW
Salix nigra	Black willow	FACW+
Viburnum dentatum	Southern arrowwood	FAC
Viburnum lentago	Nannyberry	FAC
Grasses		
Andropogon gerardii	Big bluestem	FAC

Elymus virginicus	Virginia wildrye	FACW-
Panicum virgatum	Switchgrass	FAC
Schizachyrium scoparium	Little bluestem	FACU-
Forbs		
Scientific Name	**Common Name**	**Wetland Indicator Status**
Iris versicolor	Blue flag	OBL
Peltandra virginica	Green arrow arum	OBL
Pontederia cordata	Pickerelweed	OBL

Soil Bioengineering

Soil bioengineering applies particular characteristics of vegetative components and integrates the characteristics of structural components with the vegetation. Adapted types of woody vegetation are initially installed in specific configurations that offer immediate soil protection and reinforcement. In addition, soil bioengineering systems create resistance to sliding or shear displacement in a streambank as they develop roots. Environmental benefits derived from woody vegetation include diverse and productive riparian habitats, shade, organic additions to the stream, cover for fish and improvements in aesthetic value water quality (USDA-NRCS, 1996).

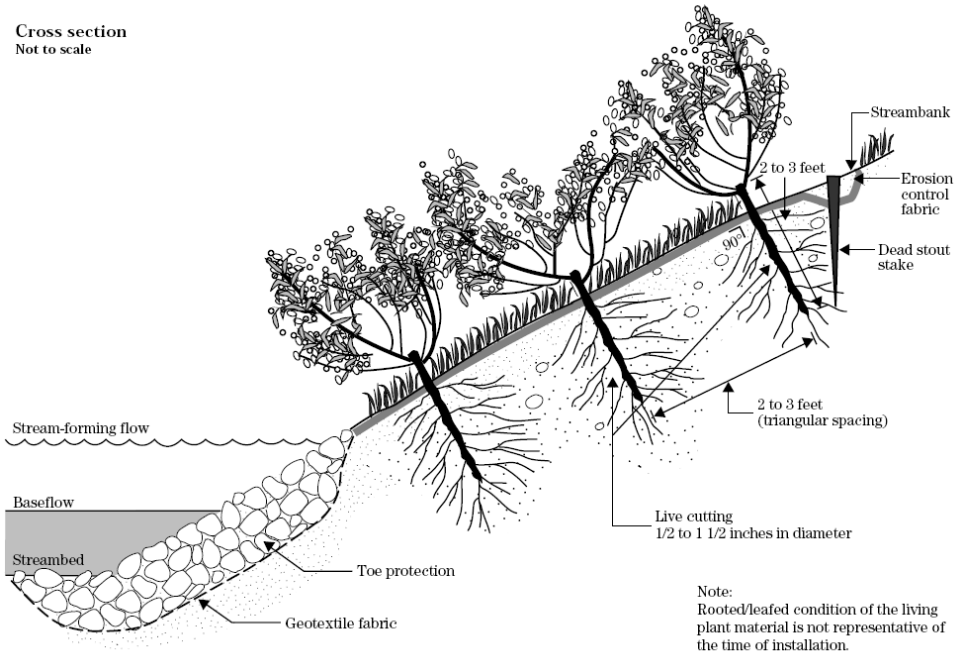
Soil bioengineering systems normally use unrooted plant parts in the form of cut branches. For streambanks, bioengineering systems include brush mattresses, live stakes, joint plantings, vegetated geogrids, branch packing, tree revetment, live crib wall and live fascines. Live stakes, live fascines, and joint plantings will be discussed in more depth in this section as they may be applicable to portions of the Lower Passaic River and tributaries where the streambank is eroded or where it is decided that hardened shorelines can be replaced with these "soft" measures. Live stakes, live fascines, and joint plantings are typically the lower cost and more easily implemented bioengineering systems.

Live Stakes: Live staking involves the insertion and tamping of live, unrooted vegetative cuttings into the ground. If correctly prepared, handled, and placed, the live stake will root and grow quickly. A system of stakes creates a living root mat that stabilizes the soil by reinforcing and binding soil particles and by extracting excess soil moisture. Most willow species root rapidly and begin to dry out a bank soon after installation.

Benefits of live stakes:

- Appropriate technique for repair of small earth slips and slumps that are frequently wet.
- Can be used to peg down and enhance the performance of surface erosion control materials.
- Enhance conditions for natural colonization of vegetation from the surrounding plant community.
- Stabilize intervening areas between other soil bioengineering techniques, such as live fascines.
- Produce streamside habitat.

Figure 5 – Live Stake Details



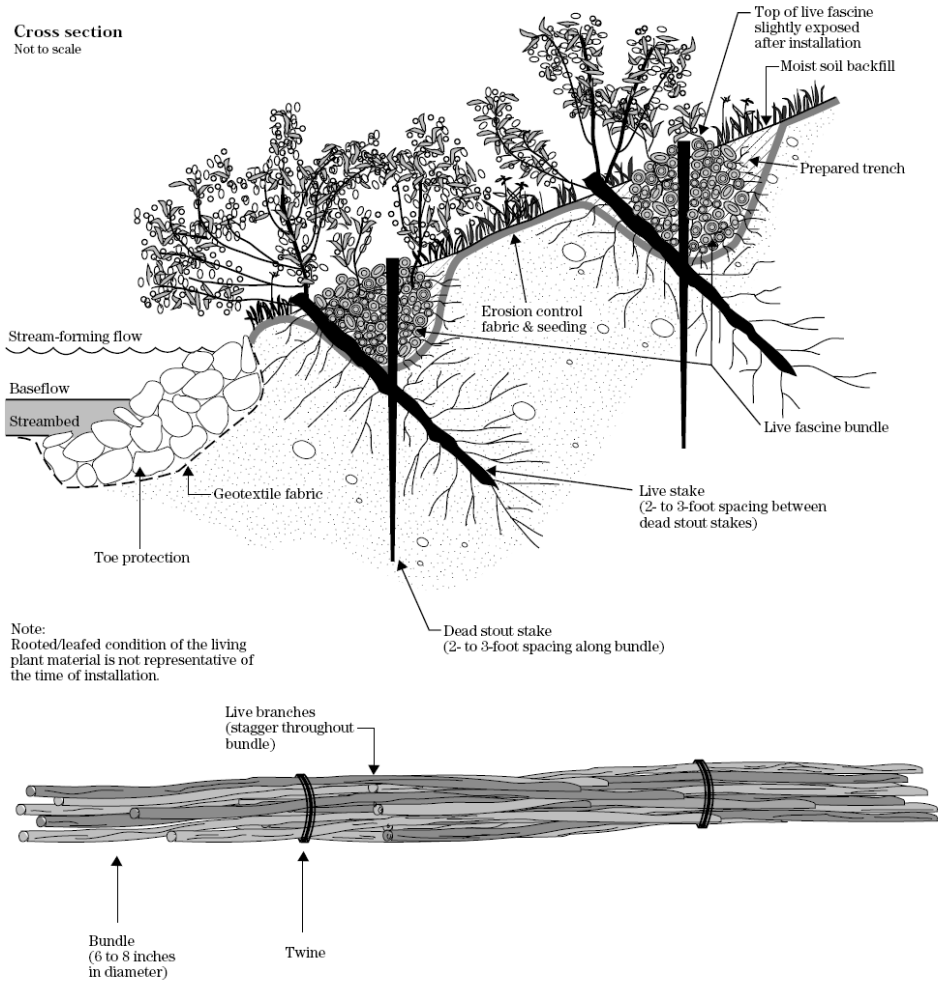
USDA-NRCS, 1996

Live Fascines: Live fascines are live branch cuttings bound together in long cylindrical bundles. They should be staked into shallow contour trenches on dry slopes and at an angle on wet slopes to reduce erosion and shallow sliding.

Benefits of live fascines:

- Effective as a stabilization technique for streambanks. When properly installed, this system does not cause much site disturbance.
- Protect slopes from shallow slides (1 to 2 foot depth).
- Offer immediate protection from surface erosion.
- Capable of trapping and holding soil on a streambank by creating small dam-like structures, thus reducing the slope length into a series of shorter slopes.
- Serve to facilitate drainage where installed at an angle on the slope.
- Enhance conditions for colonization of native vegetation by creating surface stabilization and a microclimate conducive to plant growth.

Figure 6 – Live Fascine Details



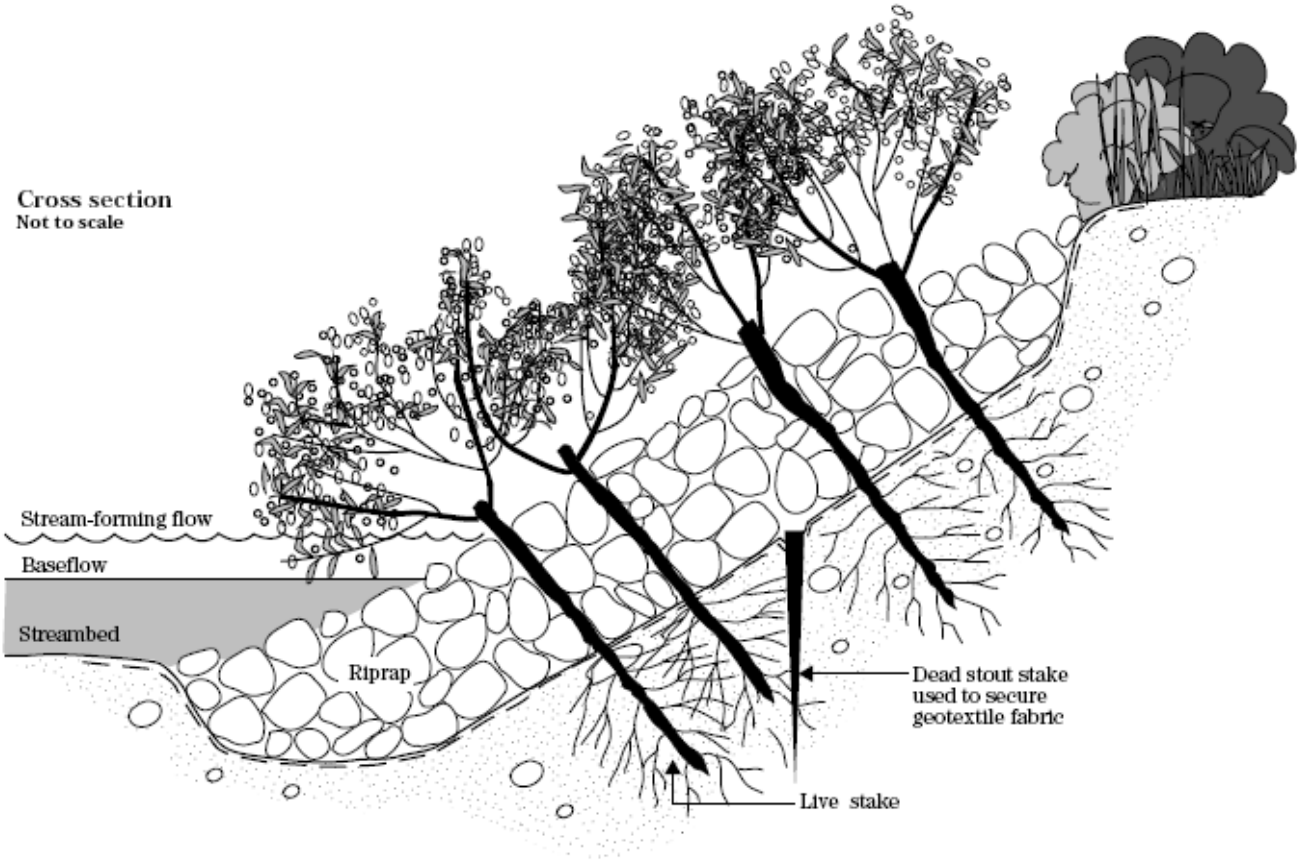
USDA-NRCS, 1996

Joint Planting: Joint planting or vegetated riprap involves tamping live stakes into joints or open spaces in rocks that have been previously placed on a slope. Alternatively, the stakes can be tamped into place at the same time that rock is being placed on the slope face.

Benefits of joint planting:

- Useful where rock riprap is required or already in place.
- Roots improve drainage by removing soil moisture.
- Over time, joint plantings create a living root mat in the soil base upon which the rock has been placed. These root systems bind or reinforce the soil and prevent washout of fines between and below the rock.
- Provides immediate protection and is effective in reducing erosion on actively eroding banks.
- Dissipates some of the energy along the streambank.

Figure 7 – Joint Planting Details



USDA-NRCS, 1996

4.6 Freshwater Forested Understory Enhancement

The understory of some forested wetlands that occur along portions of the Lower Passaic River and its tributaries are often heavily vegetated with non-native, invasive species that out compete native shrubs and herbaceous vegetation. The best example of this is the wooded areas that contain many native trees with understories that consist almost exclusively of Japanese knotweed (*Polygonum cuspidatum*). Removal of invasive species would leave the opportunity for planting the understory of these areas with native species to provide greater diversity and enhance the wildlife habitat.

Shrub species that can be planted in the understory of the freshwater forested areas include those discussed in the previous freshwater forested section such as silky dogwood (*Cornus amomum*), American hornbeam (*Carpinus caroliniana*), highbush blueberry (*Vaccinium corymbosum*), sweetbay (*Magnolia virginiana*), spicebush (*Lindera benzoin*), swamp rose (*Rosa palustris*),coastal sweet pepperbush (*Clethra alnifolia*), inkberry (*Ilex glabra*), southern arrowwood (*Viburnum dentatum*), and nannyberry (*Viburnum lentago*).

Viburnum lentago. R.A. Howard @ USDA-NRCS PLANTS Database

Herbaceous species that would provide ground cover in the understory include perennial grasses and rushes such as mannagrass (*Glyceria striata*) and fox sedge (*Carex*

Glyceria striata. Larry Allain @ USDA-NRCS PLANTS Database

vulpinoidea) that will establish rapidly. Other grasses, sedges and rushes useful for this application include tussock sedge (*Carex stricta*), wood reedgrass (*Cinna arundinacea*), Virginia wildrye (*Elymus virginicus*), and soft rush (*Juncus effuses*). The following forbs would also be suitable for this application: New England aster (*Aster novae-angliae*), New York aster (*Aster novi-belgii*), jewelweed (*Impatiens capensis*), cardinalflower (*Lobelia cardinals*), sensitive fern (*Onoclea sensibilis*), royal fern (*Osmunda regalis*), and lizard's tail (*Saururus cernuus*).

Table 7 – Freshwater Forested Understory Enhancement Plant List

Shrubs		
Scientific Name	**Common Name**	**Wetland Indicator Status**
Carpinus caroliniana	American hornbeam	FAC
Clethra alnifolia	Sweet pepperbush	FAC+
Cornus amomum	Silky dogwood	FACW
Ilex glabra	Inkberry	FACW-
Lindera benzoína	Spicebush	FACW-
Magnolia virginiana	Sweetbay	FACW+
Rosa palustris	Swamp rose	OBL
Vaccinium corymbosum	Highbush blueberry	FACW-
Viburnum dentatum	Southern arrowwood	FAC
Viburnum lentago	Nannyberry	FAC
Grasses, Sedges and Rushes		
Bromus altissimus	Canada brome	FACW
Carex intumescens	Bladder sedge	FACW+
Carex stricta	Tussock sedge	OBL
Carex vulpinoidea	Fox sedge	OBL
Cinna arundinacea	Wood reedgrass	FACW+
Elymus virginicus	Virginia wildrye	FACW-
Glyceria striata	Fowl mannagrass	OBL
Juncus effusus	Soft rush	FACW+
Forbs		
Aster novae-angliae	New England aster	FACW-
Aster lanceolatus	Lined aster	FACW
Aster novi-belgii	New York aster	FACW+
Boehmeria cylindrica	False nettle	FACW+
Impatiens capensis	Jewelweed	FACW
Lobelia cardinals	Cardinalflower	FACW+
Mertensia virginica	Virginia bluebells	FACW

Onoclea sensibilis	Sensitive fern	FACW
Osumunda cinnamomea	Cinnamon fern	FACW
Osmunda regalis	Royal fern	OBL
Saururus cernuus	Lizard's tail	OBL
Symplocarpus foetidus	Skunk cabbage	OBL

4.7 Riparian Buffer (Seeding)

Riparian buffers provide numerous environmental and recreational benefits to streams, groundwater, and downstream land areas; therefore, efforts to preserve and improve them are an important part of successful restoration plans. Buffers have been found to increase groundwater infiltration; decrease streambank erosion; filter sediments and pollutants commonly found in runoff; provide floodwater storage; increase wildlife habitat; and provide recreation areas. Consideration should be given to revegetating areas that have been cleared or fragmented, especially where streambank erosion is a problem.

Direct seeding is regarded as an efficient means of re-establishing native vegetation. It is cost-effective compared with other methods and is relatively easy to do. A diverse mixture of plants can be established through direct seeding, the main limit being the availability of seeds. Seeds are broadcast, by either hand or machine, directly onto prepared ground.

Advantages of direct seeding:

- Relatively inexpensive;
- Requires less time and labor than planting seedlings;
- Large areas can be sown rapidly;
- Seedlings develop good root systems and tap roots; therefore, means the plants are able to handle climatic extremes better and require little maintenance; and
- A diverse seed mix can be sown, including seeds for trees, shrubs and groundcovers to mimic the natural environments.

Disadvantages of direct seeding:

- Direct seeding can be less reliable than planting seedlings;
- Results can range from prolific germination of a diverse range of species through prolific germination of one or a few species;
- Seed predation can be a problem;
- Poor seasonal conditions, such as low rainfall, can affect germination;
- Poor soil conditions, such as heavy clay soils or highly erodible soils, can affect germination; and
- Requires careful pre-planning and site treatment for effective weed control.

The majority of the species discussed in this document can be acquired from a nursery as seed as well as small plants. The planting lists for the river section where riparian seeding is proposed recommend the appropriate plant species. Several of the native plant nurseries provided in this document have pre-prepared seed mixes available that are targeted towards erosion control. For example, New England Wetland Plants has an Erosion Control/Restoration Mix appropriate for recently disturbed sites that require quick revegetation and soil surface stabilization (other native plant nurseries listed in Table 1 may provide a similar plant seed mix). This would be an appropriate seed mix for road cuts, pipelines, detention basin side slopes, and areas requiring temporary cover during the ecological restoration process.

5.0 Planting Windows

The best time to plant vegetation is during the dormant season. In the northeast, this will typically be late fall and early spring, but can vary by region and seasonal weather conditions. Planting at other times of the year may be possible, but will often require supplements such as irrigation, fertilizers and/or hormone growth enhancement in order for plants to be viable. Planting in the middle of summer, especially if conditions are dry, is not recommended.

Successful tree and shrub plantings are achieved in both spring and fall. Early spring planting is generally considered best and should be completed prior to the end of June. However, fall from mid-September until the ground freezes, is can also be an excellent time to plant woody trees and shrubs. Fall plantings are well insulated over winter so roots are able to establish and have will access to available water during the spring flush. Late fall is considered to best time of the year for bare root planting.

When planting for a streambank stabilization project, live stakes of dogwoods should be planted in early spring, preferably before May and should not be planted after June 1st. Establishment with other species, such as willow and other riparian species is a good practice to increase diversity. For example, on sites with banks that may become dry over the summer, utilizing silky dogwood next to the water, with willows above, helps to ensure that stabilization will occur regardless. Immediately after planting trees and shrubs, grasses and legumes may be planted to provide initial stabilization.

As a general rule, freshwater emergent species and salt marsh species such as smooth cordgrass should be planted from April 1st to June 1st. This allows the plants to grow and develop a strong root system before the winter. If necessary planting can occur earlier than April 1st as long as it is past the last frost date. Fall planting (September 1st to October 15th) is possible, but not desirable as the over-winter survival of the plants can be compromised by ice, frost heaves and other winter damage. Aquatic emergent species should be planted in early spring after the final frost.

Since seeds require moisture to germinate, seeding at a restoration site should take place at the time of year when moisture is available. For most areas in the northeast, this occurs during the spring or fall. However, summer plantings are possible if irrigation is available and the species can tolerate higher temperatures. For instance, when properly watered, warm season grasses can thrive when planted in June and July. Winter is not an appropriate time as temperatures are too cold for germination.

6.0 Invasive Species Management

6.1 Pre-planting Invasive Species Management

Native vegetation may be absent as a result of competitive exclusion by invasive species. The greater the amount of invasive species that can be removed from the site prior to planting, the greater the chance that the restoration project will succeed. The most effective methods of invasive removal will differ for various plant species. Sometimes a combination of two or more of the removal methods is most effective. For example, one commonly used combination of weed control for herbaceous weeds is to shallowly till the site; allow the invasives to begin growing; spray with a glyphosate herbicide, such as Rodeo or TOUCHDOWN PRO; wait ten days, then spray again if weeds resprout. Note that if an herbicide is used, a non-residual should be chosen to prevent detrimental effects on the site later and permits will be required from NJDEP. In addition to these methods, there is potential during the construction phase of the project to incorporate a narrow ditch around the perimeter of the wetland. This

can provide and aquatic barrier that could prevent encroachment of invasives into the marsh. Below is a list of common methods used for invasive plant and noxious weed removal:

Physical Removal:
- Pulling;
- Mowing;
- Burning; and
- Tilling.

Smothering:
- Artificial mulch: plastic, landscape fabric, cardboard, newspaper;
- Biological mulch: hay, wood chips, compost; and
- Cover crop: growing a sterile (non-reproducing) annual that will outcompete weeds then die off.

Chemical Control (permit required from NJDEP):
- Pre-emergent herbicide (prevents seeds from germinating);
- Post-emergent herbicides (kills plants after they begin to grow);
    - contact: kills the surface part of the plant that it comes in contact with;
    - systemic: affects the whole plants' internal biochemical pathways; and
    - selective: only harms specific plant types (e.g. only broadleaf grasses).

Ecological Control:
- Shade;
- Flood;
- Change disturbance patterns;
- Change available nutrient levels; and
- Change soil pH.

6.2 Post-planting Invasive Species Management

Following installation of new native plants, controlling the recruitment and spread of invasive plant species is an important element to ensure the success of a restoration project. Once established, invasive species can outcompete native species, form dense stands, and eventually dominate an entire plant community. Invasive plants that are a persistent problem at a restoration site will need continual monitoring.

Methods for controlling invasive species recruitment include the following:
- Early detection and eradication of new weed invasions;
- Containing neighboring weed infestations;
- Minimizing soil disturbances; and
- Managing for healthy native plants.

Early detection and eradication of new weed invasions: If a new infestation is detected at an early stage and the plants are removed before seeds are produced, efforts and resources will be saved. Even if some plants are detected after seed production, but before a large population increase, less work is required for removal. One method commonly used to prevent invasion is to regularly survey the restoration site, removing individual plants before they become established and begin seed production. The infestation area should be identified on a map of the site, marked in the field, and continually monitored during subsequent surveys.

Containing neighboring weed infestations: Since restoration sites do not exist in a vacuum and are often situated within a larger disturbed landscape, there is a good chance that weed populations will be found in areas adjacent to or nearby the site. One approach to controlling the spread of invasives is to spray the borders of the infested area with an herbicide. Containment programs are typically designed only to limit the spread of a weed population, and thus can require a long-term commitment to herbicide application. Permitting can also be required for herbicide spraying.

Minimizing soil disturbance: Most weed species have developed characteristics, such as rapid growth rates and high seed production, which enable them to move into a bare ground site quickly and aggressively. They often are able to outcompete native species in occupying disturbed soil. Therefore, it is important to minimize soil disturbance in a restoration project wherever possible.

Managing for healthy native plants: In areas where native species have been planted, it is important to manage the landscape accordingly so that the native plants remain healthy and strong and invasive encroachment is limited.

7.0 Regulatory Requirements

Restoration efforts along the Lower Passaic River, including the shoreline stabilization projects, will require permits prior to construction. Below is a description of permits that may be required although this is not an exhaustive list. Prior to restoration activities it will be necessary to contact the appropriate regulatory officials to determine which permits will apply to a particular project.

- **USACE Section 404 of the Clean Water Act – Discharges of dredged and fill material into Waters of the U.S. and Section 10 of the Rivers and Harbors Act**

Fills authorized by the Corps as part of bank construction will be authorized by the USACE under the authority of an Individual Permit. Project-specific Coastal Zone Management (CZM) Program Certification Concurrences will be required from the state of New Jersey as part of the Waterfront Development Permit and a project-specific Water Quality Certification (WQC) will be required from New Jersey.

- **NJDEP Waterfront Development Permit Application**

The NJDEP Division of Land Use Regulation (DLUR) is responsible for the oversight and management of the tidal waters and wetlands. DLUR exercises its authority and responsibility through implementation of different state laws, including the Waterfront and Harbor Facilities Act of 1914 ("Waterfront Development Law"), the Coastal Wetlands Act of 1970, the Coastal Area Facility Review Act, the Freshwater Wetlands Protection Act, Shore Protection laws, Tidelands Statutes, the Ninety-Day Construction Permit Law, and the Harbor Clean-Up Bond Issues of 1977 and 1980.

- **NJDEP Flood Hazard Area (formerly Stream Encroachment) Permit Application**

A Flood Hazard Area Permit is required from DLUR for projects located within fluvial (i.e., non-tidal) floodplains, to ensure that the project will not result in an increased risk to life and property, due to changes in the hydrology and/or hydraulics of the affected watercourse(s) and their associated floodplain(s).

- **NJPDES Soil Erosion and Sediment Control Plan Certification**

All projects that involve land disturbances greater than 5,000 sq. ft. require Soil Erosion and Sediment Control (SE&SC) Plan Certification from the local Soil Conservation District (SCD).

- **NJDEP Tidelands Act, N.J.S.A. 12:3**

Tidelands, also referred to as riparian lands, are "…lands…flowed by the mean high tide of a natural waterway." Use of these lands, which are owned by the people of New Jersey, requires authorization from the Tidelands Resource Council in the form of a grant, license, lease, or Statement of No Interest.

- **NJDEP Aquatic Pesticide Use Permit**

N.J.A.C. 7:30-9.3 mandates that an Aquatic Pesticide Permit is required for most applications of pesticides to any waters of the State or aquatic sites. All pesticides labeled for aquatic use are restricted use in New Jersey. The purchase and application of a restricted use pesticide requires certification and licensing as a pesticide applicator. An application of ANY pesticide to an aquatic site requires an Aquatic Pesticide Permit.

8.0 Master Plant List

Table 8 – Master Plant List

Trees and Shrubs		
Scientific Name	**Common Name**	**#River Section**
Acer negundo	Boxelder	BE
Acer rubrum	Red maple	TF, FF
Alnus rugosa	Speckled alder	BE
Amorpha fruiticosa	Desert false indigo	BE
Aronia arbutifolia	Red chokeberry	TB
Baccharis halimifolia	Eastern baccharis	TB, TT
Carpinus caroliniana	American hornbeam	FF, UE
Celtis occidentalis	Common hackberry	TB, TT
Cephalanthus occidentalis	Common buttonbush	TT, TF
Clethra alnifolia	Coastal sweet pepperbush	TT, FF, UE
Cornus amomum	Silky dogwood	TF, FF, BE, UE
Cornus sericea	Red-osier dogwood	BE
Fraxinus pensylvanica	Green ash	TF, FF
Ilex glabra	Inkberry	TB, TT, TF, FF, UE
Iva fructescens	Jesuit's bark	TB
Juniperus virginiana	Eastern red cedar	TB, TT
Lindera bezoin	Spicebush	FF, UE
Liquidambar styraciflua	Sweetgum	TT, TF, FF
Magnolia virginiana	Sweetbay	TT, FF, UE

Table 8 (continued) – Master Plant List		
Trees and Shrubs		
Scientific Name	**Common Name**	***River Section**
Myrica pensylvanica	Bayberry	TB, TT
Nyssa sylvatica	Blackgum	TF, FF
Platanus occidentalis	Sycamore	FF, BE
Prunus maritima	Beach plum	TB
Prunus serotina	Black cherry	TT
Quercus bicolor	Swamp white oak	FF
Quercus palustris	Pin oak	FF
Rhus copallinum	Winged sumac	TT
Rosa palustris	Swamp rose	FF, UE
Salix discolor	Pussy willow	BE
Salix nigra	Black willow	TF, FF, BE
Sambucus canadensis	American black elderberry	TF
Spirea latifolia	Meadowsweet	TF
Vaccinium corymbosum	Highbush blueberry	FF, UE
Viburnum dentatum	Southern arrowwood	TF, FF, BE, UE
Viburnum lentago	Nannyberry	TF, FF, BE, UE
Grasses, Sedges, and Rushes		
Andropogon gerardii	Big bluestem	TB, BE
Bouteloua curtipendula	Side-oats grama	TB
Bromus altissimus	Canada brome	UE
Carex crinita	Fringed sedge	FF
Carex intumescens	Bladder sedge	UE
Carex lurida	Shallow sedge	TF
Carex scoparia	Broom sedge	TF
Carex stricta	Tussock sedge	FF, UE
Carex vulpinoidea	Fox sedge	TF, FF, UE
Cinna arundinacea	Wood reedgrass	FF, UE
Cyperus strigosus	Strawcolored flatsedge	TF
Dichanthelium clandestinum	Deertongue	TF
Distichilis spicata	Saltgrass	TB
Eleocharis palustris	Common spikerush	TF
Elymus virginicus	Virginia wildrye	TF, FF, BE, UE
Glyceria striata	Fowl mannagrass	TF, FF, UE
Juncus effusus	Soft rush	TF, FF, UE
Juncus gerardii	Saltmeadow rush	TB, TT

Table 8 (continued) – Master Plant List		
Grasses, Sedges, and Rushes		
Scientific Name	**Common Name**	***River Section**
Juncus tenuis	Poverty rush	TF
Panicum virgatum	Switchgrass	TB, TT, BE
Schizachyrium scoparius	Little bluestem	TB, BE
Scirpus (Schoenoplectus) acutus	Hardstem bulrush	TT, TF
Scirpus (Schoenoplectus) americanus	Chairmaker's bulrush	TB, TF
Scirpus atrovirens	Green bulrush	TF
Scirpus cyperinus	Woolgrass	TF
Scirpus (Schoenoplectus) tabernaemontani	Softstem bulrush	TT
Spatina alternifolia	Smooth cordgrass	TB
Spartina cynosuroides	Big cordgrass	TB, TT
Spartina patens	Saltmeadow cordgrass	TB
Spartina pectinata	Prairie cordgrass	TT
Zizania aquatica	Annual wildrice	TF
Forbs		
Acorus americanus	Sweetflag	TT
Alisma plantago-aquatica	Water plantain	TF
Asclepias incarnata	Swamp milkweed	TF
Asclepias tuberosa	Butterfly milkweed	TB
Aster lanceolatus	Lined aster	UE
Aster prenanthoides	Crooked-stem aster	TB
Aster nove-angliae	New England aster	TB, FF, UE
Aster novi-belgii	New York aster	TB, TT, FF, UE
Aster tenuifolius	Perennial saltmarsh aster	TT, TB
Boehmeria cylindrical	False nettle	UE
Bidens coronata	Crowned beggarticks	TF
Castilleja coccinea	Scarlet Indian paintbrush	TB
Conoclinium coelstinum	Blue mistflower	TB
Coreopsis lanceolata	Lance-leaved tickseed	TB
Euthamia graminifolia	Grass-leaved goldenrod	TT, TF
Heliopsis helianthoides	Ox-eyed sunflower	TB
Hibiscus moscheutos	Marsh hibiscus	TT, TF
Impatiens capensis	Jewelweed	FF, UE
Iris versicolor	Blue flag	TF, BE
Lobelia cardinals	Cardinalflower	FF, UE
Leucanthemum vulgare	Oxeye daisy	TB
Lupinus perennis	Perennial lupine	TB
Mertensia virginica	Virginia bluebells	UE

Table 8 (continued) – Master Plant List		
Forbs		
Scientific Name	**Common Name**	***River Section**
Nuphar lutea	Yellow pond-lily	TF
Oenothera speciosa	Showy evening primrose	TB
Onoclea sensibilis	Sensitive fern	FF, UE
Osmunda cinnamomea	Cinnamon fern	UE
Osmunda regalis	Royal fern	FF, UE
Peltandra virginica	Green arrow arum	TT, TF, BE
Penstemon digitalis	Beardtongue	TB
Phlox paniculata	Fall phlox	TB
Polygonum arifolium	Halberd-leaved tearthumb	TF
Polygonum hydropiperoides	Swamp smartweed	TF
Polygonum sagitatum	Arrow-leaved tearthumb	TF
Pontederia cordata	Pickerelweed	TT, TF, BE
Rudbekia hirta	Black-eyed Susan	TB
Rudbekia triloba	Brown-eyed Susan	TB
Rumex verticillatus	Swamp dock	TF
Sagittaria graminea	Grass-leaved arrowhead	TB
Sagittaria latifolia	Duck potato	TF
Sambucus canadensis	Elderberry	TF
Samolus floribundus	Water pimpernel	TB
Saururus cernuus	Lizard's tail	FF, UE
Solidago elliotii	Coastal swamp goldenrod	TB
Solidago juncea	Early goldenrod	TB
Solidago sempervirens	Seaside goldenrod	TT, TB
Symplocarpus foetidus	Skunk cabbage	UE
Verbena Astata	Blue vervain	TF
Vernonia noveboracensis	New York ironweed	TF

[#]TB=Tidal Brackish, TT=Tidal Transitional, TF=Tidal Freshwater, FF=Freshwater Forested, BE=Bioengineering, UE=Understory Enhancement

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