Hartman (2003b)

Mill Creek Wetlands Mitigation Site
Fourth Annual Monitoring Report
2003

Prepared for

The New Jersey Meadowlands Commission
Division of Planning and Management, Wetlands and Water Quality

In Partial Fulfillment of Requirements for

United States Department of the Army Permit
93-03412
and
New Jersey Department of Environmental Protection Permit
0909-92-0003

on the behalf of
New Jersey Transit Corporation

Prepared by

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November 2003

Newark Bay Study Area
NBSA-00111

Errata:

1. The second paragraph under Section 4.0, page 11 of the text, "savanna sparrow" should be "savannah sparrow".
2. The fifth paragraph under Section 5.0, page 12 of the text, "*Paulowina tomentosa*" should be "*Paulownia tomentosa*".
3. The caption for Figure 5 of Appendix D should read "was sufficient ~~enough~~ to…".
4. The caption for Figure 6 of Appendix D should read "Aquatic plants enhance…".

New Jersey Transit Corporation Permitted Area
Mill Creek Marsh Wetlands Mitigation Site
Fourth Annual Monitoring Report
2003

Executive Summary

This report presents monitoring observations made during the fourth growing season (2003) after completion of construction of the Mill Creek Marsh Mitigation Site, Hackensack Meadowlands District. The Department of Army Corp Permit #93-03412 and NJDEP Permit #0909-92-0003 required wetland enhancement or restoration of 45 acres for impacts to 13.1 acres of wetlands associated with the Secaucus Transfer Station project. The goals of the wetland mitigation design at the Mill Creek Site included: the control of Phragmites australis, *the re-establishment of tidal flow across the site, and the creation of open-water areas. These goals are met by the design implementation.*

During the spring and summer monitoring events, fifty four (54) plant species were identified within the thirteen (13) permanent monitoring plots. There is limited re-establishment of Phragmites australis. *Recommendations focus on how to maintain the successional trajectory towards a sustainable tidal marsh community.* Spartina *seeding and fencing is also recommended.*

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1.0 Introduction

1.1 Background

The Department of the Army (Corps) permit number 93-03412 and the New Jersey Department of Environmental Protection (NJDEP) permit number 0909-92-0003 authorized the discharge of fill materials and performance of construction activities impacting approximately 13.1 acres of water and wetlands to facilitate the development of the Secaucus Railroad Transfer Station, including construction of a filled embankment, access roads, aerial towers for utility lines, and stormwater- outfall structures. The project was located in the Town of Secaucus and Jersey City, Hudson County.

1.2 Mitigation Goals and Requirements

The permits required the New Jersey Transit Corporation (NJ Transit) to provide New Jersey Meadowlands Commission (NJMC) five million dollars for a wetland mitigation project for the enhancement, creation, or restoration of at least 45 acres of wetlands at Block 185, Lot 2.03, in the town of Secaucus, Hudson County, commonly known as the Mill Creek Wetlands Mitigation Site (Site) (Figure 1). Prior to mitigation, the area was covered by a dense monoculture of common reed (*Phragmites australis)*, with little open water and reduced tidal flow.

1.3 Overview of Wetland Mitigation at Mill Creek Mitigation Site

The NJMC developed a wetland mitigation design for the Mill Creek Site that was submitted to and approved by the Corps.

The primary goals of wetland enhancement at the Site are:

- to increase open-water areas through the creation of impoundments and tidal channels,
- to re-establish tidal flow through site manipulation and water-control structures,
- to enhance upland and emergent fringe vegetation, and
- to create habitat for the endangered least tern.

In compliance with this permit, the mitigation plan required grading of the marsh surface to create additional open-water areas, including the enhancement of tidal channels and the creation of two shallow impoundments. An island with a shell substrate was constructed in the interior of the Site to provide breeding habitat for *Sterna albifrons*. The design enhances low marsh habitats through the control of *Phragmites australis* and improves lowland scrub-shrub passerine habitats along the marsh/upland ecotone. It also creates new habitat accommodating dabbling duck, shorebird, and wading bird breeding; creates wintering and migratory habitats; and provides greater fishery access. A secondary component of the design includes a public walking trail and benches for quiet contemplation and wildlife-watching along the upland areas of the Site.

Review of the "as-built" confirms that these plan elements are sited as detailed in the permit. The "as-built total area" permitted to NJ Transit encompasses 59.54 acres. This includes 7.63

acres of upland transition and upland and 51.91 acres of wetland, which is greater than the permit required.

1.4 Monitoring

A Memorandum of Understanding was executed between the NJMC and Rutgers University in December 1998 to perform monitoring activities associated with documenting the results of the mitigation efforts at the Site. The following discussions present observations recorded by Rutgers during the fourth growing season after completion of construction activities.

2.0 Materials and Methods

2.1 Quantitative Sampling

A total of sixty-one (61) permanent plots were established throughout the entire 137-acre Site in June 2000 and an additional eight (8) were added in 2001 (Figure 1). Sixty-nine (69) plots were used in the studies. Ten (10) permanent 10' by 10' plots were established within the NJ Transit permitted area (Area) in June 2000 (5, 6, 11, 17, 50, 53, 58, 59, 60, and 62) (Figure 2). An additional three (3) plots were established in this Area in July 2001 (70, 71, and 73). Due to the dynamic nature of the marsh system and the extremely harsh winter, plots 50, 58, 62, and 70 were re-established in the Spring of 2003 prior to monitoring. Plots 50, 58, and 62 were all re-established within 7 feet of the original plots and plot 70 was re-established approximately 56 ft from the original plot due to the large amount of wood and log debris covering that location. The plot numbers are not totally sequential within each permitted area of the Site. Vegetation monitoring was conducted in June (Spring) and again in August (Summer) according to protocols detailed in Appendix A.

A summary of the 2003 data is shown in Appendix B. Digital photographs of the plots were taken at the time of each sampling in the spring and summer (Appendix C). A digital camera was held at eye level at the northeast corner of each plot, and the focus and meter settings were selected to maximize the field of view. Various markers were placed within the plot or at the edge of the plot to help clarify the plot boundaries.

Site elevations (feet NAVD88) are depicted on Figure 2. Four elevation zones were identified to define habitats based on inundation characteristics observed during the fieldwork (Table 1). The zone names indicate the category of salt-marsh vegetation expected to become established (Day *et al.* 1989, Mitsch and Gosselink 1993). The elevation ranges reflect site-specific flood patterns observed by the monitoring staff during 2000 and indicated on the "as-built" survey.

Table 1. Elevation Ranges for Vegetation Zones

Elevation (NAVD88)	Vegetation Zone
<1'	Channels/Mudflat
1'-2.5'	Low Marsh*
2.5'-5.0'	High Marsh*
>5.0'	Upland Transition and Upland

*Referred to collectively as emergent marsh

2.2 Vegetation Cover Map

Using a 2001 color infrared aerial photograph and detailed field observations, landmarks were identified on the Site and used to establish baselines and transects for field measurement and identification of vegetation zones. From field data, vegetation cover polygons were created using a GIS (ESRI's ArcView 3.2). Digitizing was accomplished by using field measurements and ArcView 3.2's Measure tool with the aerial photograph. Acreage of the different vegetation zones was calculated by using ArcView 3.2's Tabulate Areas tool and by conversion of ArcView shapefiles into ESRI's ArcGIS 8.1 coverage files. The final layouts for the vegetation cover maps were produced using ArcGIS 8.1.

3.0 Results and Discussion

Implementation of the mitigation plan resulted in the creation of approximately 24.17 acres of open water, 12.20 acres of mudflat, 13.43 acres of emergent/low marsh, 4.19 acres of upland transition, and 4.78 acres of upland.

Successful implementation of the mitigation plan is determined by the achievement of vegetative coverage. Therefore, this report focuses on the criterion of 85% areal cover of wetland species in low marsh and high marsh zones. An overview of the system restoration is given in Appendix D.

3.1 Vegetation Sampling in Permanent Plots

Thirteen (13) monitoring plots were sampled during Summer 2002 and forty-six (46) vascular plant species were identified at that time. These plots provide a quantitative description of the successional establishment of vegetation in the Area and Appendix B presents the details of vegetation monitoring results. Percent Cover and Relative Percent Cover for species grouped by "Region 1 Indicator Status" are presented and discussed below. The results of the Summer sampling are used because it is representative of vegetation establishment within the Area. Because the cover sampling methodology utilized allows for overlapping of plants (and, therefore Total Cover of greater than 100%), Relative Percent Cover was also calculated, which adjusts Total Cover to 100%.

3.1.1 Channels/Mudflat Zone

Four (4) monitoring plots were established in the channels/mudflat zone where twelve (12) species of plants were identified in Summer. There were no vascular plants in two of the plots while the other two plots were dominated by *Eleocharis parvula,* an obligate wetland species. In one of these plots, *Eleocharis parvula* was the sole species present, but in the other plot, it was one of twelve (12) species, including seven (7) obligate wetland species and four (4) facultative wetland species. Information regarding the species of plants in this zone and their occurrence in each of the monitoring plots is located in Appendix B. Based on analysis of the data, which is presented in Table 2, 35.63% of cover in this zone was attributed to obligate and facultative wetland species. Although vegetation coverage information is being presented for this zone to demonstrate the diversity of the wetland system, this zone should not be subjected to the 85% coverage requirement because microphytobenthos and benthic invertebrates rather than vascular plants dominate the biological community.

Table 2. Cover of Vegetation by Indicator Status in Channels/Mudflat Zone

Indicator Status	Cover (%)	Relative Cover (%)
Obligate Wetland Species	30.00	75.00
Facultative Wetland Species	5.63	14.06
Other Species	4.37	10.94
TOTAL	40.00	100.00

3.1.2 Emergent Marsh *(Listed as Emergent/Low Marsh on Figures 3a and 3b)*

Seven (7) emergent marsh plots were established. These seven plots can be further distinguished as "low marsh" and "high marsh" and are reported separately in this document to provide a more detailed understanding of the vegetation dynamics of the Area.

3.1.2.a Low Marsh Zone

Three (3) monitoring plots were established in the low marsh zone, and sixteen (16) species of plants were identified. Nine (9) of these species were obligate wetland species and four (4) were facultative wetland species. All of the plots were dominated by obligate wetland species. Plot 6 was dominated by *Amaranthus cannabinus* and *Eleocharis parvula*, plot 17 by *Polygonum hydropiperoides*, and plot 58 by *Polygonum hydropiper.* Information regarding the dominant species and occurrence of each species in the monitoring plots is located in Appendix B. Based on analysis of the data, which is presented in Table 3, 95.83% of cover in this zone was attributed to obligate and facultative wetland species.

Although the overall wetlands species cover for the low marsh zone is above the required 85 %, within the impoundments there are areas with low wetland species cover (Appendix B).

Table 3. Cover of Vegetation by Indicator Status in Low Marsh Zone

Indicator Status	Cover (%)	Relative Cover (%)
Obligate Wetland Species	90.00	91.53
Facultative Wetland Species	5.83	5.93
Other Species	2.50	2.54
TOTAL	98.33	100.00

3.1.2.b High Marsh Zone

Four (4) monitoring plots were established in the high marsh zone, and twenty-nine (29) species of plants were identified. Nine (9) of these species were obligate wetland species and eight (8) were facultative wetland species. *Eleocharis parvula*, an obligate wetland species, was dominant in three of the plots while *Calystegia sepium*, a facultative species, was dominant in the fourth plot. Information regarding the dominant species and occurrence of each species in each of the monitoring plots is located in Appendix B. Based on analysis of the data, which is presented in Table 4, 103.76% of cover in this zone was attributed to obligate and facultative wetland species.

Table 4. Cover of Vegetation by Indicator Status in High Marsh Zone

Indicator Status	Cover (%)	Relative Cover (%)
Obligate Wetland Species	76.88	56.16
Facultative Wetland Species	26.88	19.63
Other Species	33.12	24.21
TOTAL	136.88	100.00

3.2 Vegetation Map

Two distinct cover maps were created – an areal covereage of vegetation and an areal coverage of elevation zones. The Vegetation Cover Map (Figures 3a and 3b) depicts the current, but dynamic, plant coverage from September 2003. The vegetation is generally consistent with the maps submitted with the previous reports; however, field observations made during the summer of 2003 resulted in more detailed vegetation data, because zonation is becoming somewhat more apparent. The Elevation Zone Map (Figure 4) depicts the predicted zones for the mature system. Elevation and tidal inundation patterns will ultimately control the mature vegetation patterns. Figure 4 uses this information, along with establishment patterns of target perennial plant cover, to illustrate the predicted zones.

As with any developing restoration project, the vegetation community of Mill Creek is dynamic and will change and settle out as the system undergoes succession. Figures 3a and 3b illustrate the current successional stage of the vegetation community after the third growing season. Figure 4 depicts the predicted end point of the successional process. However, it is important to note that because the site is highly dynamic, some of the current and predicted vegetation and elevation zones may shift due to natural marsh system processes. For example, the areas designated as "upland transition" will include the wetland delineation line eventually and, therefore, will be divided into the upland and high marsh zones. The delineation will be determined in the final year of monitoring, after soil development and plant establishment patterns have had more time to become distinct.

As shown on Figures 3a and 3b, and presented in Table 5, the open water, mudflat, and emergent marsh zones make up most of the enhancement features of this Area. Field observations and analysis of color infrared aerial photography indicate that *Phragmites* is present in the emergent marsh (1.50% of the total coverage of this zone), upland transition (0.39%), and upland (0.41%) zones. While *Phragmites* is present in these zones, it is not dominant over the entire Area (total *Phragmites* coverage for this Area is 2.30%). The majority of the *Phragmites*-dominated acres is found scattered along the western boundary of the Area. While these sections are included in the NJ Transit boundary, some were not enhanced or restored as the rest of the Site has been.

Table 5. Areal Coverage of Vegetation Types

Vegetation Zone	Acres	*Phragmites*-Dominated Acres
Open Water	23.69	0
Mudflat	12.30	0
Emergent Marsh	14.46	0.88
Upland Transition	4.07	0.23
Upland	4.25	0.24
TOTAL	58.77	1.35

3.3 Mitigation Goals

Although the primary purpose of the monitoring report is to document the establishment of vegetation within the Area, the monitoring program also includes observations and studies of the Area that can more fully demonstrate that the Area is performing many of the wetland functions outlined in the mitigation plan. The elimination of stands of *Phragmites* within the enhanced sections is one indication of increased biodiversity. Channels and mudflats are well integrated into this mitigated marsh system. Their presence improves the long-term success of *Spartina alterniflora* establishment and dominance as well as improving the function of the Area in its role as a fishery breeding ground.

4.0 Conclusions

The mitigation plan for the fulfillment of NJ Transit permit requirement has been implemented at the Mill Creek as approved by the Corps. This report demonstrates that overall vegetation coverage is dominated by obligate and facultative wetland species. The required 85% coverage of wetland species has been exceeded in the low and high marsh zones.

The significant use of the Area by the avian community – which includes the state threatened savanna sparrow, osprey, and black-crowned night heron; the state endangered northern harrier and black skimmer; and the state and federally endangered peregrine falcon – also demonstrates the successful execution of the plan.

5.0 Recommendations

We recommend:

- continuation and expansion of fencing and a *Spartina* seeding/planting program for the upcoming growing season,
- management of the Canada goose population, following Best Management Practices of USDA, should be continued or broadened,
- herbicide applications to any surrounding areas dominated by *Phragmites*,
- spot applications and removal of *Phragmites* in areas where the cover of this species is expanding and mixed with target wetland species, and
- monitoring for and management of invasive plant species.

The first two of these recommendations were implemented at the Site after NJMC staff reviewed the 2002 Monitoring Report. Previous successful seeding/planting and fencing programs within the Site have shown that the site design is suitable for supporting a low marsh community in the appropriate elevation zone. Although there is a healthy community of wetland species within a majority of the low marsh zone, portions within the impoundments still have a low wetland species cover. To ensure the establishment of a healthy low marsh plant community across the Site, we suggest the continuation and expansion of fencing and *Spartina* seeding/planting programs within the impoundments. The magnitude of the Canada goose population is largely responsible for preventing establishment of *Spartina*. Therefore, the Canada goose population management program instituted in cooperation with USDA is essential to the continued long-term success of the wetland enhancement.

Some expansion of the *Phragmites australis* population has occurred in the higher zones of vegetation. As in previous years, we recommend that the management of these patches must be maintained and implemented at regular intervals to prevent the species from dominating the Area. Within the NJ Transit permitted area there has been a large expansion of the *Phragmites* population since last year. We recommend spot application of herbicide and repeated close clipping for at least one season to prevent spread of this population.

The fifth recommendation is new this year because patches of invasive species have been found within the Site. Within the NJ Transit permitted area *Calystegia sepium*, a known invasive

species, has become established and is preventing the successful establishment of desired wetland species. We recommend that an aggressive management plan be implemented, including physical removal and/or herbicide application.

Also within the NJ Transit permitted area a few individuals of *Polygonum cuspidatum*, another known invasive species, have become established. Beginning with only a few individuals, *Polygonum cuspidatum* can rapidly expand and dominate an area by producing rhizomatous shoots and viable seeds. We recommend the complete removal of any *Polygonum cuspidatum* individuals from this area via cutting and herbicide application to prevent its dominance.

Within the NJ Transit permitted area individuals of *Paulowina tomentosa*, a known invasive species, have become established. Although *Paulowina tomentosa* provides some structure to the community it represents a large seed source, which if not removed will allow for its continued expansion throughout the Site. We recommend early hand pulling of seedlings and cutting of mature plants.

Small populations of the highly invasive *Lythrum salicaria* have also been found within the Area. The *Lythrum* management program currently being implemented at the Harrier Meadow Wetlands Mitigation Site should be expanded to include the NJ Transit permitted area. Because the *Lythrum* populations are isolated and small, implementation of a management program at this stage will be highly effective.

6.0 References

Day, J.W., Jr., C.A.S. Hall, W.M. Kemp, and A. Yanez-Aranciba. 1989. Estuarine Ecology. Wiley, NY.

Mitsch, W., and J.G. Gosselink. 1993. Wetlands (2nd edition). Van Nostrand Reinhold, NY.

Figure 1

NJ Transit Permitted Area Site Map
Showing Permanent Vegetation Monitoring Plots
(Post-Construction Orthophoto)

Mill Creek Marsh Wetland Mitigation Site

New Jersey Meadowlands Commission

NJ Transit Permanent Plots

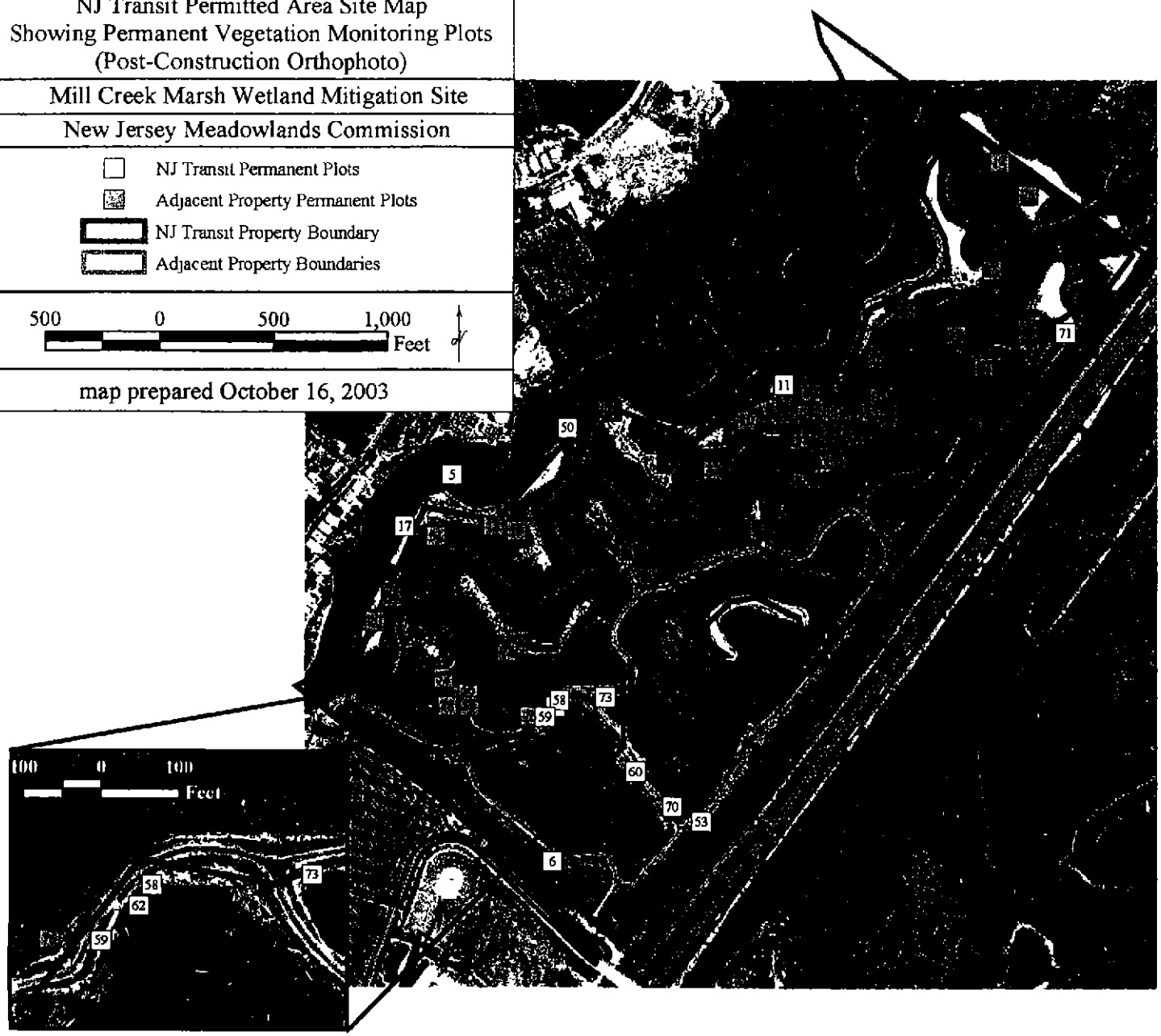
Adjacent Property Permanent Plots

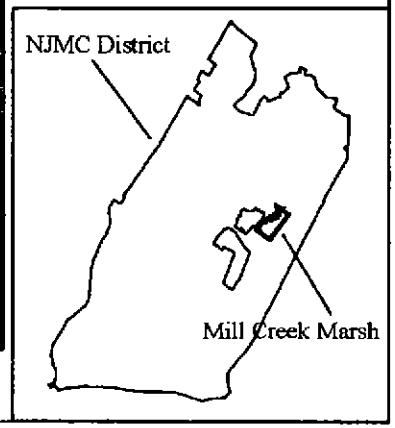
NJ Transit Property Boundary

Adjacent Property Boundaries

500 0 500 1,000 Feet

map prepared October 16, 2003





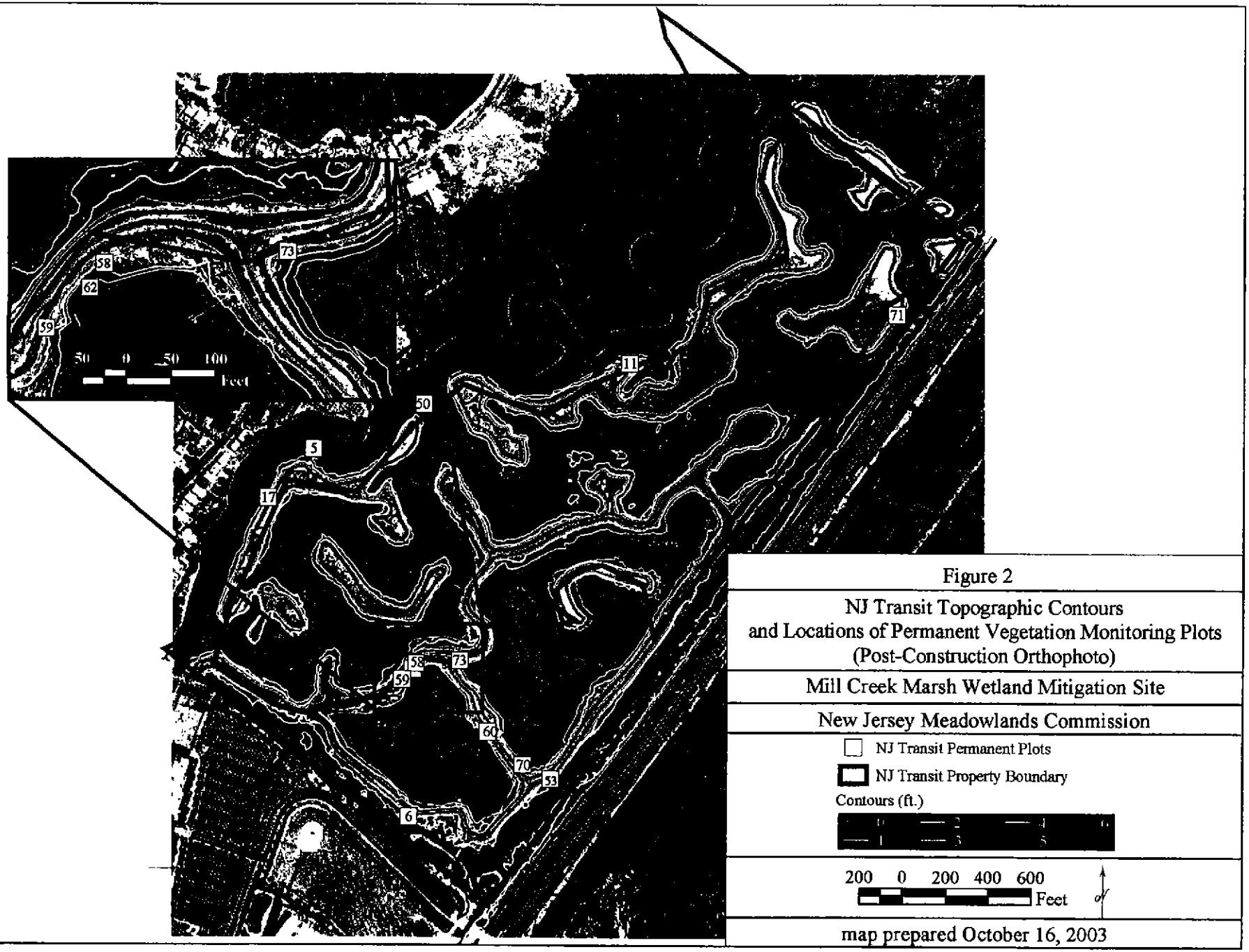


Figure 2

NJ Transit Topographic Contours
and Locations of Permanent Vegetation Monitoring Plots
(Post-Construction Orthophoto)

Mill Creek Marsh Wetland Mitigation Site

New Jersey Meadowlands Commission

NJ Transit Permanent Plots

NJ Transit Property Boundary

Contours (ft.)

map prepared October 16, 2003

APPENDIX B:

Summary of Vegetation Data, 2003

Table B-1
Vascular Plant Species Found in Permanent Plots at NJ Transit Permitted Area
Mill Creek Marsh, Hudson County, New Jersey, 2003

Species	Common Name	Indicator Status	Seasons Found	
			Spring	Summer
Ailanthus altissima	Tree of Heaven	FACU-	X	X
Amaranthus cannabinus	Saltmarsh Water Hemp	OBL	X	X
Andropogon gerardii	Big Bluestem	FAC-		X
Apocynum cannabinum	Indian Hemp	FACU	X	
Artemisia vulgaris	Common Mugwort	UPL	X	X
Aster subulatus	Annual Saltmarsh Aster	OBL	X	X
Atriplex patula	Orach	FACW	X	X
Baccharis halimifolia	Groundsel Tree	FACW	X	X
Barbarea vulgaris	Yellow Rocket	FACU	X	
Calystegia sepium	Hedge Bindweed	FAC-		X
Chenopodium album	White Goosefoot	FACU+	X	X
Chenopodium glaucum	Oak Leaved Goosefoot	FACW-		X
Cirsium arvense	Canada Thistle	FACU	X	
Cirsium vulgare	Bull Thistle	FACU-	X	X
Cirsium sp.				X
Convolvulus arvensis	Field Bindweed		X	
Cornus sericea	Red Osier Dogwood	FACW+	X	X
Cuscuta gronovii	Common Dodder			X
Cyperus strigosus	Straw-Color Flatsedge	FACW		X
Cyperus sp.				X
Daucus carota	Wild Carrot		X	
Eleocharis parvula	Small Spikerush	OBL	X	X
Erechtites hieraciifolia	American Burn	FACU	X	
Eupatorium album	White Bracted Euparotium		X	
Festuca elatior	Meadow Fescue	FACU	X	X
Festuca ovina	Sheep Fescue	NI	X	X
Hibiscus moscheutos	Swamp Rose-Mallow	OBL		X
Hibiscus sp.			X	
Lactuca serriola	Prickly Lettuce	FAC-		X
Lepidium virginicum	Poor Man's Pepper	FACU-	X	
Lycopus americanus	Water Horehound	OBL	X	X
Morus alba	White Mulberry	UPL	X	X
Oenothera biennis	Common Evening Primrose	FACU-	X	X
Panicum virgatum	Switchgrass	FAC		X
Phragmites australis	Common Reed	FACW	X	X
Phytolacca americana	Common Pokeweed	FACU+	X	X
Pluchea odorata	Saltmarsh Fleabane	OBL	X	X
Polygonum aviculare	Doorweed	FACU	X	

Table B-1
Vascular Plant Species Found in Permanent Plots at NJ Transit Permitted Area
Mill Creek Marsh, Hudson County, New Jersey, 2003

Species	Common Name	Indicator Status	Seasons Found	
			Spring	Summer
Polygonum hydropiper	Water Pepper	OBL		X
Polygonum hydropiperoides	Swamp Smartweed	OBL	X	X
Polygonum pensylvanicum	Pennsylvania Smartweed	FACW		X
Polygonum persicaria	Lady's Thumb	FACW	X	X
Polygonum sp.			X	
Prunus serotina	Wild Black Cherry	FACU		X
Rorippa palustris	Common Yellow Cress	OBL		X
Rumex altissimus	Pale Dock	FACW-	X	
Rumex maritimus	Golden Dock	FACW		X
Rumex sp.			X	
Sambucus canadensis	American Elder	FACW	X	X
Schizachyrium scoparium	Little Bluestem	FACU-	X	X
Scirpus americanus	Olney's Bullrush	OBL	X	X
Solanum dulcamara	Purple Nightshade	FAC	X	X
Solanum nigrum	Black Nightshade		X	X
Solidago sempervirens	Seaside Goldenrod	FACW	X	
Sorghastrum nutans	Indian Grass	UPL	X	X
Spartina alterniflora	Saltmarsh Cordgrass	OBL	X	X
Thlaspi arvense	Field Penny Cress	UPL	X	
Verbena hastata	Blue Vervain	FACW+	X	X
Zannichellia palustris	Horned Pondweed	OBL	X	
Plot 11 Unknown 1				X
Plot 11 Unknown 2				X
Plot 11 Unknown 3			X	
Plot 21 Unknown 1				X
Plot 59 Unknown 1			X	

Note:

"Indicator Status" refers to wetland indicator status for Region 1 wetlands.

"Indicator Status" Key:

OBL = Obligate Wetland

FACW = Facultative Wetland

FAC = Facultative

FACU = Facultative Upland

UPL = Obligate Upland

NI = No Indicator Status

Blank = Not included in the National List of Vascular Plant Species that Occur in Wetlands.

+ or - sign indicates a tendency toward higher or lower frequency of occurrence within a category.

Table B-2
Summary of Vegetation Data for NJ Trai
Spring 2003 Sampling
Mill Creek Marsh, Hudson County

	Plot 5		Plot 6		Plot 11		Plot 17		Plot 50		Plot 53		Plot 5	
	Channels/ Mudflat		Low Marsh		High Marsh		Low Marsh		Channels/ Mudflat		Upland		Low Ma	
Species	Freq[1]	Cover[2]	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	C
Ailanthus altissima	0		0		0		0		0		4	1	0	
Amaranthus cannabinus	0		37	2	0		1	1	0		0		0	
Apocynum cannabinum	0		0		1	1	0		0		0		0	
Artemisia vulgaris	0		0		0		0		0		0		0	
Aster subulatus	0		18	1	3	1	30	1	0		0		51	1
Atriplex patula	0		37	1	66	3*	92	2*	0		32	1	12	
Baccharis halimifolia	0		0		8	1	0		0		30	4*	2	
Barbarea vulgaris	0		0		0		0		0		0		0	
Chenopodium album	0		0		0		0		0		0		0	
Cirsium arvense	0		0		0		0		0		7	1	0	
Cirsium vulgare	0		0		0		0		0		81	3	0	
Convolvulus arvensis	0		0		54	3*	0		0		0		0	
Cornus sericea	0		0		0		0		0		0		0	
Daucus carota	0		0		0		0		0		0		0	
Eleocharis parvula	72	1	100	2*	0		55	2	0		0		13	1
Erechtites hieraciifolia	0		0		0		0		0		0		0	
Eupatorium album	0		0		0		0		0		0		0	
Festuca elatior	0		0		23	3	0		0		14	2	0	
Festuca ovina	0		0		0		0		0		0		0	
Hibiscus sp.	0		0		1	1	0		0		5	1	0	
Lepidium virginicum	0		0		0		0		0		0		0	
Lycopus americanus	0		0		9	1	0		0		0		0	
Morus alba	0		0		0		0		0		2	1	0	
Oenothera biennis	0		3		0		0		0		1	1	2	1
Phragmites australis	0		0		36	2	3	1	0		0		1	1
Phytolacca americana	0		0		13	2	0		0		0		0	
Pluchea odorata	0		1		0		69	1	0		0		2	1
Polygonum aviculare	0		0		0		0		0		0		0	
Polygonum hydropiperoides	0		0		0		0		0		0		0	
Polygonum persicaria	0		31	1	13	1	64	2	0		9	1	12	1
Polygonum sp.	0		0		0		33	1	0		0		0	
Rumex altissimus	0		0		0		0		0		2	1	0	
Rumex sp.	0		0		0		1	1	0		0		0	
Sambucus canadensis	0		0		0		0		0		1	1	0	
Schizachyrium scoparium	0		0		12	1	0		0		0		0	
Scirpus americanus	0		0		0		5	1	0		0		0	
Solanum dulcamara	0		0		0		0		0		2	1	0	
Solanum nigrum	0		0		0		0		0		0		4	1
Solidago sempervirens	0		0		0		0		0		0		0	
Sorghastrum nutans	0		0		1	1	0		0		0		0	
Spartina alterniflora	0		21	1	2	1	0		0		0		0	
Thlaspi arvense	0		0		0		0		0		0		0	
Verbena hastata	0		0		0		0		0		35	2	0	
Zannichellia palustris	89	1*	0		0		0		0		0		0	
Plot 11 Unknown 3	0		0		5	1	0		0		0		0	
Plot 59 Unknown 1	0		0		0		0		0		0		0	
Cover (%)		**5.00**		**40.00**		**167.50**		**62.50**		**0.00**		**160.00**		**22.50**

[1]**Quadrat Occurrence Data:** This data shows the number of 1' by 1' quadrats that each species occurred in for each 10' by 10' plot. The maximum value per plot is 1

[2]**Plot Cover Rank:** After 100 quadrats were sampled for species presence, a visual estimate of cover was recorded for the plot. 1:0-5%, 2:5-25%, 3:25-50%; 4:50-75

*Indicates dominant species.

Summary of Vegetation Data for NJ Transit Permitted Area

Spring 2003 Sampling

Mill Creek Marsh, Hudson County, New Jersey

	Plot 17		Plot 50		Plot 53		Plot 58		Plot 59		Plot 60		Plot 62		Plot 70		Plot 71		Plot 73	
h	Low Marsh		Channels/ Mudflat		Upland		Low Marsh		High Marsh		Upland		Channels/ Mudflat		Channels/ Mudflat		High Marsh		High Marsh	
r	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover
	0		0		4	1	0		0		0		0		0		0		0	
	1	1	0		0		0		0		0		0		1	1	0		4	1
	0		0		0		0		0		0		0		0		0		0	
	0		0		0		0		0		4	1	0		0		0		0	
	30	1	0		0		51	1*	25	1	7	1	0		0		60	1*	7	1
	92	2*	0		32	1	12	1	15	1	96	2	0		0		20	1	11	1
	0		0		30	4*	2	1	0		0		0		0		4	1	0	
	0		0		0		0		0		5	1	0		0		0		0	
	0		0		0		0		0		1	1	0		0		0		0	
	0		0		7	1	0		0		0		0		0		0		0	
	0		0		81	3	0		0		37	2	0		0		0		0	
	0		0		0		0		0		0		0		0		0		0	
	0		0		0		0		0		5	2	0		0		0		0	
	0		0		0		0		1	1	1	1	0		0		0		0	
	55	2	0		0		13	1	50	1*	0		0		77	1*	18	1	56	1*
	0		0		0		0		0		1	1	0		0		0		0	
	0		0		0		0		0		3	1	0		0		0		0	
	0		0		14	2	0		0		1	1	0		0		0		0	
	0		0		0		0		0		1	1	0		0		0		0	
	0		0		5	1	0		0		0		0		0		0		0	
	0		0		0		0		0		18	1	0		0		0		0	
	0		0		0		0		0		0		0		0		0		0	
	0		0		2	1	0		0		0		0		0		0		0	
	0		0		1	1	2	1	0		63	3*	0		0		0		0	
	3	1	0		0		1	1	0		0		0		0		2	1	0	
	0		0		0		0		0		9	1	0		0		0		0	
	69	1	0		0		2	1	14	1	0		0		3	1	0		2	1
	0		0		0		0		1	1	0		0		0		0		0	
	0		0		0		0		0		1	1	0		0		0		0	
	64	2	0		9	1	12	1	0		1	1	0		0		1	1	0	
	33	1	0		0		0		0		0		0		0		0		0	
	0		0		2	1	0		0		0		0		0		0		0	
	1	1	0		0		0		0		0		0		0		0		0	
	0		0		1	1	0		0		0		0		0		0		0	
	0		0		0		0		0		0		0		0		0		0	
	5	1	0		0		0		0		0		0		0		0		0	
	0		0		2	1	0		0		0		0		0		0		0	
	0		0		0		4	1	1	1	0		0		0		0		0	
	0		0		0		0		4	1	0		0		0		0		0	
	0		0		0		0		0		0		0		0		0		0	
	0		0		0		0		0		0		0		10	1	0		1	1
	0		0		0		0		0		3	1	0		0		0		0	
	0		0		35	2	0		0		0		0		0		0		0	
	0		0		0		0		0		0		0		0		0		0	
	0		0		0		0		0		0		0		0		0		0	
	0		0		0		0		1	1	0		0		0		0		0	
		62.50		0.00		160.00		22.50		22.50		117.50		0.00		10.00		15.00		15.00

ies occurred in for each 10' by 10' plot. The maximum value per plot is 100.

of cover was recorded for the plot. 1:0-5%; 2:5-25%; 3:25-50%; 4.50-75%; 5:75-100%.

Table B-3
Summary of Vegetation Data for NJ Transit Permitted Area
Summer 2003 Sampling
Mill Creek Marsh, Hudson County, New Jersey

	Plot 5		Plot 6		Plot 11		Plot 17		Plot 50		Plot 53		Plot 58		Plot 59	
	Channels/ Mudflat		Low Marsh		High Marsh		Low Marsh		Channels/ Mudflat		Upland		Low Marsh		High Marsh	
Species	Freq[1]	Cover[2]	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover
Ailanthus altissima	0		0		0		0		0		2	1	0		0	
Amaranthus cannabinus	0		48	3*	0		0		0		0		9	2	28	3
Andropogon gerardii	0		0		1	1	0		0		0		0		0	
Artemisia vulgaris	0		0		0		0		0		0		0		0	
Aster subulatus	0		0		21	1	1	1	0		0		19	1	3	1
Atriplex patula	0		2	1	53	1	11	1	0		0		13	1	1	1
Baccharis halimifolia	0		0		23	2	0		0		20	4*	7	1	1	1
Calystegia sepium	0		0		68	4*	0		0		0		0		0	
Chenopodium album	0		0		0		0		0		0		0		0	
Chenopodium glaucum	0		0		0		0		0		0		1	1	0	
Cirsium vulgare	0		0		0		0		0		8	1	6	1	0	
Cirsium sp	0		0		0		0		0		13	1	0		0	
Cornus sericea	0		0		0		0		0		0		0		0	
Cuscuta gronovii	0		0		0		0		0		3	1	0		0	
Cyperus strigosus	0		0		1	1	1	1	0		0		13	1	29	1
Cyperus sp.	0		0		0		0		0		0		0		0	
Eleocharis parvula	39	1*	87	3*	0		66	1	0		0		31	1	100	4*
Festuca elatior	0		0		0		0		0		0		0		0	
Festuca ovina	0		0		26	2	0		0		10	1	0		0	
Hibiscus moscheutos	0		0		7	2	0		0		7	1	0		0	
Lactuca serriola	0		0		0		0		0		0		0		0	
Lycopus americanus	0		0		31	2	0		0		0		1	1	0	
Morus alba	0		0		0		0		0		4	2	0		0	
Oenothera biennis	0		0		42	2	0		0		4	1	3	1	0	
Panicum virgatum	0		0		8	1	0		0		0		0		0	
Phragmites australis	0		0		40	2	0		0		0		0		0	
Phytolacca americana	0		0		2	1	0		0		0		0		0	
Pluchea odorata	0		2	1	15	1	65	2	0		0		21	1	56	2
Polygonum hydropiper	0		31	3	2	1	0		0		0		26	2*	2	1
Polygonum hydropiperoides	0		0		28	1	90	5*	0		8	1	3	1	4	1
Polygonum pensylvanicum	0		0		2	2	0		0		0		0		0	
Polygonum persicaria	0		0		14	2	0		0		0		0		0	
Prunus serotina	0		0		0		0		0		1	1	0		0	
Rorippa palustris	0		0		0		0		0		0		1	1	0	
Rumex maritimus	0		0		0		0		0		0		0		0	
Sambucus canadensis	0		0		1	1	0		0		1	2	0		0	
Schizachyrium scoparium	0		0		11	1	0		0		0		0		0	
Scirpus americanus	0		0		0		0		0		0		0		11	1
Solanum dulcamara	0		0		2	1	0		0		1	1	1	1	0	
Solanum nigrum	0		0		3	1	0		0		0		0		0	
Sorghastrum nutans	0		0		20	1	0		0		0		0		0	
Spartina alterniflora	0		1	1	0		0		0		0		0		0	
Verbena hastata	0		0		0		0		0		8	1	0		0	
Plot 11 Unknown 1	0		0		11	1	0		0		0		0		0	
Plot 11 Unknown 2	0		0		1	1	0		0		0		0		0	
Plot 21 Unknown 1	0		0		4	1	0		0		0		0		0	
Cover (%)		2.50		120.00		230.00		112.50		0.00		125.00		62.50		137.50

[1]**Quadrat Occurrence Data:** This data shows the number of 1' by 1' quadrats that each species occurred in for each 10' by 10' plot. The maximum value per plot is 100

[2]**Plot Cover Rank:** After 100 quadrats were sampled for species presence, a visual estimate of cover was recorded for the plot. 1:0-5%; 2.5-25%; 3.25-50%; 4.50-75%; 5:75-100%.

*Indicates dominant species.

Table B-3
Summary of Vegetation Data for NJ Transit Permitted Area
Summer 2003 Sampling
Mill Creek Marsh, Hudson County, New Jersey

ot 6	Plot 11		Plot 17		Plot 50		Plot 53		Plot 58		Plot 59		Plot 60		Plot 62		Plot 70		Plot 71		
Marsh	High Marsh		Low Marsh		Channels/ Mudflat		Upland		Low Marsh		High Marsh		Upland		Channels/ Mudflat		Channels/ Mudflat		High Marsh		Hig
Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Frec
	0		0		0		2	1	0		0		0		0		0		0		0
3*	0		0		0		0		9	2	28	3	0		0		1	1	0		5
	1	1	0		0		0		0		0		0		0		0		0		0
	0		0		0		0		0		0		2	1	0		0		0		0
	21	1	1	1	0		0		19	1	3	1	1	1	0		1	1	17	1	7
1	53	1	11	1	0		0		13	1	1	1	14	1	0		2	1	11	1	12
	23	2	0		0		20	4*	7	1	1	1	2	1	0		0		10	1	0
	68	4*	0		0		0		0		0		0		0		0		0		0
	0		0		0		0		0		0		0		0		3	1	0		1
	0		0		0		0		1	1	0		0		0		0		0		0
	0		0		0		8	1	6	1	0		35	3	0		0		0		0
	0		0		0		13	1	0		0		0		0		0		0		0
	0		0		0		0		0		0		2	1	0		0		0		0
	0		0		0		3	1	0		0		0		0		0		0		0
	1	1	1	1	0		0		13	1	29	1	0		0		63	2	7	1	53
	0		0		0		0		0		0		0		0		43	2	0		3
3*	0		66	1	0		0		31	1	100	4*	0		0		91	4*	64	3*	80
	0		0		0		0		0		0		1	1	0		0		0		0
	26	2	0		0		10	1	0		0		0		0		0		0		0
	7	2	0		0		7	1	0		0		0		0		1	1	0		0
	0		0		0		0		0		0		0		0		0		1	1	0
	31	2	0		0		0		1	1	0		1	1	0		0		1	1	0
	0		0		0		4	2	0		0		0		0		0		0		0
	42	2	0		0		4	1	3	1	0		69	5*	0		0		0		0
	8	1	0		0		0		0		0		0		0		0		0		0
	40	2	0		0		0		0		0		0		0		0		0		0
	2	1	0		0		0		0		0		21	2	0		1	1	2	1	0
1	15	1	65	2	0		0		21	1	56	2	0		0		0		0		0
3	2	1	0		0		0		26	2*	2	1	0		0		94	3	46	1	50
	28	1	90	5*	0		8	1	3	1	4	1	4	1	0		1	1	0		0
	2	2	0		0		0		0		0		0		0		0		0		1
	14	2	0		0		0		0		0		0		0		0		0		0
	0		0		0		1	1	0		0		0		0		0		9	1	0
	0		0		0		0		1	1	0		0		0		0		0		0
	0		0		0		0		0		0		0		0		0		0		0
	1	1	0		0		1	2	0		0		0		0		1	1	0		1
	11	1	0		0		0		0		0		0		0		0		0		0
	0		0		0		0		0		0		0		0		0		0		0
	2	1	0		0		1	1	1	1	0		0		0		0		10	1	0
	3	1	0		0		0		0		0		0		0		0		0		0
	20	1	0		0		0		0		0		0		0		0		0		3
1	0		0		0		0		0		0		0		0		0		0		0
	0		0		0		8	1	0		0		2	1	0		0		0		0
	11	1	0		0		0		0		0		0		0		0		0		0
	1	1	0		0		0		0		0		0		0		0		0		0
	4	1	0		0		0		0		0		0		0		0		0		0
.00		230.00		112.50		0.00		125.00		62.50		137.50		162.50		0.00		157.50		62.50	

quadrats that each species occurred in for each 10' by 10' plot. The maximum value per plot is 100

nce, a visual estimate of cover was recorded for the plot. 1:0-5%; 2:5-25%; 3:25-50%; 4:50-75%; 5:75-100%.

APPENDIX D:

Summary of Vegetation Cover at Mill Creek

Overview of the Mill Creek Marsh Wetlands Mitigation Site

Background

The New Jersey Meadowlands Commission (NJMC) developed a wetland mitigation design for the 137-acre Mill Creek Site (the Site), which was implemented and completed in December 1999. The purpose of the mitigation project was to increase the ability of the Mill Creek wetland to provide water quality improvement, fisheries and wildlife habitat, and recreation/education opportunities. While tidal flushing in Mill Creek and the network of existing mosquito ditches was good, the majority of the site experienced tidal action only with the highest tides each month or during storm tides. Moreover, while Mill Creek and the ditches attracted wildlife, the majority of the site was dominated by a monoculture of common reed (*Phragmites australis*), which provided very limited wildlife habitat for the majority of species (Figure 1). Therefore, the overall objective was to grade the Site to increase the amount of area that experiences regular, tidal inundation and to create a more diverse and complete low marsh estuarine system, consisting of emergent, mudflat, and open-water areas (Figure 2).

The NJMC, on behalf of various permittees, accepted the requirement to perform wetlands mitigation projects for approved wetlands impacts resulting from U.S. Army Corps of Engineer (Corps) and New Jersey Department of Environmental Protection (NJDEP) permits. These permittees provided the NJMC with the funds necessary to execute the mitigation projects. Table 1 presents the list of the various permits that are assigned to portions of the Site.

Components of mitigation design for the Site included the grading of the marsh surface to create additional meanders in existing tidal channels and the excavation of shallow impoundments; upland waterfowl habitat nesting, resting, and foraging islands with access to open water; and an island in the interior of the Site to provide breeding habitat for the endangered least tern (*Sterna albifrons*) (Figure 2).

The mitigation project has provided low marsh habitats that are flushed daily by the tides; lowland scrub-shrub passerine habitats along the marsh/upland ecotone; dabbling duck, shorebird, and wading bird breeding, wintering, and migratory habitats (Figure 3); greater fishery access; and some degree of mosquito control. A secondary component of the design includes a passive park and walking trail along the upland areas of the Site.

Vegetation Monitoring

Sixty-nine (69) permanent monitoring plots have been established at the Site; the majority of the plots were established in June of 2000. Continuous evaluation of the monitoring program with regards to obtaining the most reliable and credible data resulted in the addition of seven (7) plots during 2001. Nineteen (19) plots were established in the channels/mudflat zone, eighteen (18) in the low marsh zone, seventeen (17) in the high marsh zone, and fifteen (15) in the upland zone.

Vegetation Establishment

Vegetation establishment patterns were strong during 2003, which was the fourth growing season after construction activities were completed (Figure 4, Table 2). The vegetation of the low and high marsh areas was mainly composed of annual facultative and obligate wetland species (Table 3). Perennial species that are considered typical of tidal wetlands, such as *Spartina alterniflora*, were present but were not dominant.

Wetland indicator status and percent cover for the different habitat zones within the Site are reported in Table 2. The low marsh plots were dominated by wetland species. While the average percent cover was just under 85%, studies demonstrated that system conditions in the marsh are favorable for the establishment of the targeted species. The low marsh has experienced a large increase in vegetation cover from 64.17% in 2002 to 82.22% in 2003, indicating that the low marsh should achieve the required 85% wetland species cover next year. Management of herbivory and *Phragmites* re-establishment, as well as seeding in areas where wetland species establishment is not strong, are key to success at the Site.

The high marsh had an average percent cover that is greater than the required 85% cover by wetland species. This zone experienced a significant increase in wetland plant species cover from 67.65% in 2002 to 114.12% in 2003. During 2002, there was an extensive drought that negatively impacted the wetland species of this zone. The abundant rainfall in 2003 allowed the wetland species populations to recover from the drought. Although the required 85% cover has been achieved, additional management, including seeding and planting of selected areas, should be conducted to help ensure the long-term viability of the high marsh zone and assist all portions of the marsh in meeting the required 85% cover.

The mudflat habitat zone of a salt marsh is typically dominated by microphytobenthos and benthic invertebrates and not vascular plant species. However, in an undisturbed salt marsh, mudflat zones do support small populations of submerged aquatic vegetation. These submerged aquatic species are an important resource to the fish communities of an estuarine system. Within Mill Creek we have found naturally colonizing populations of the native aquatic plant *Zannichellia palustris* (Figure 5), indicating that the mudflats of this restored marsh are providing needed resources to the fish communities of the Hackensack Meadowlands.

Management of Herbivory

Several herbivore species, especially Canada geese, graze the vegetation in the Site constantly. Experimental caging of small plots in 2001 demonstrated that the grazing pressure was sufficient to prevent establishment of some species and reduce the growth of all species in the wetland zone (Figure 6). This was especially true in the lowest intertidal zone. As a result, much of the area that was appropriate for colonization by *Spartina alterniflora* was sparsely colonized by spike rush (*Eleocharis* spp.). In July 2001 and again in June 2003, NJMC contracted to have portions of the low marsh zone seeded and/or planted with *Spartina alterniflora* and fenced to reduce herbivory (Figures 7 and 8). *Spartina alterniflora* has since become established in a majority of the seeded/planted and fenced areas. The fencing also increased survival of *Eleocharis* and other low marsh species.

The monitoring staff will submit specific seeding and planting recommendations for 2004 after the monitoring reports are completed for 2003.

Vegetation Mapping

Using a 2001 color infrared aerial photograph and detailed field observations, landmarks were identified on the Site and used to establish baselines and transects for field measurement and identification of vegetation zones. From field data, vegetation cover polygons were created using a GIS (ESRI's ArcView 3.2). Digitizing was accomplished by using field measurements and ArcView 3.2's Measure tool with the aerial photograph. Acreage of the different vegetation zones was calculated by using ArcView 3.2's Tabulate Areas tool and by conversion of ArcView shapefiles into ESRI's ArcGIS 8.1 coverage files. The final layouts for the vegetation cover maps were produced using ArcGIS 8.1.

The vegetation cover types present at the Site are depicted on the Vegetation Cover Maps (Figure 9) in each monitoring report. The vegetation zones are generally consistent with the maps submitted with the previous reports, however, field observations made during the summer of 2003 permitted alterations to the previous classifications. Specifically, it was possible to indicate all *Phragmites*-dominated areas and to describe successional vegetation zones.

The upland zone is characterized by the vegetation typically found in newly disturbed soil; this vegetation is dominated by facultative upland species. The upland transition is a mixture of high marsh and upland species, as is expected for the zone. High marsh species dominated areas at the lower elevations and upland species dominated the higher elevations. Therefore, the final wetland delineation line is expected to divide this zone. *Eleocharis* spp. patches dominate the low marsh and mudflats in those areas where seeding and fencing did not occur. In most of the areas that were seeded and fenced, both *Spartina alterniflora* and *Eleocharis* spp. are well established.

Summary

The habitat zones are well integrated in the Site. Drainage of mudflat and low marsh areas is effective for establishment and long-term dominance by *Spartina alterniflora* and *Eleocharis* spp. Ongoing management of the Canada goose population, by methods such as nest disturbance, during the vegetation establishment period will improve the rate of success. Additional seeding and planting of areas with low coverage will help to ensure that the required 85% coverage is met for the entire Mill Creek Site.

The wetland enhancement at the Mill Creek Site has not only increased vegetation diversity but has also increased the diversity of other species as demonstrated by observations of benthic invertebrates, fiddler crabs, insects, fish, and avian use of the Site.

Table 1. Acreage Associated with Each Permit in the Mill Creek Mitigation Site

Permittee	Permit Numbers ACOE	Permit Numbers NJDEP	Acreage Required	Total Acreage	Upland	Upland Transition	Emergent / Low marsh	Mudflat	Open Water
New Jersey Transit	93-03412	0909-92-0003	45	60.73	4.25	4.07	14.46	12.30	23.69
New Jersey Department of Transportation	3.78+.17	0205-96-0001.4 (WFD/WQC/SE)	30.6	41.11	4.28	3.49	12.01	12.53	8.80
Jet Aviation	94-05821-RS	0237-90-001.4 (WQC)	0.48	1.39	0.25	0.53	0.30	0.31	0.00
Port Authority (I)	97-09200	0000-90-002.14 (IP/WQC)	14	18.90	2.35	2.48	4.27	6.51	3.29
Port Authority (II)	N/A	0000-90-0022.20 (IP/WQC)	4.5	6.20	0.87	0.67	1.79	2.62	0 25
Hugo Neu Schnitzer East (HNSE)	N/A	0906-96-001.5 (WFD)	0.6	0.61	0.000	0.016	0.041	0.448	0.105
New Jersey Meadowlands Commission Advance Credit	97-09150	0909-91-0001.5	10.9	11.75	0.00	1.56	5.78	4.42	0.00
Permits Assigned to parts of New Jersey Meadowlands Advance Credit*									
Allied Signal	N/A	0212-95-0001.8 (WFD) 0212-95-0001.9 (GP4	0.76	1.45	0.35	0.35	0.47	0.25	0.03
Chemical Land Holdings, Inc. (CLH)	N/A	0714-99-003.2 (WFD)	0.16	0.22	0 02	0.04	0.03	0.13	0.00
Consolidated Rail Corporation (ConRail/CSX)	98-12190	0249-93-0003-4 (WQC)	0.12	0.14	0.00	0.03	0 05	0.05	0.01
HMEC Emergency Egress	99-14310	0232-90-0001 7 (WQC)	0.277	0.28	0 00	0 00	0 00	0.20	0 07
Port Authority (Advance Credit)	97-09150	0909-91-0001.5 (WFD/WQC)	4.772	6.40	0.83	0 59	1.46	3.19	0 33
Rutherford Lodging	98-00720	0245-98-0004.1 (WQC)	0 008	0.013	0.000	0 008	0.005	0 00	0.00

Table 2: Percent Cover According to Wetland Indicator Status

Indicator Status	Channels/ Mudflats	Low Marsh	High Marsh	Upland
Obligate Wetland Species	0.32	75.97	46.91	1.33
Facultative Wetland Species	2.50	4.86	44.41	42.83
Facultative Species	0.53	0.28	10.59	51.17
Facultative Upland Species	18.42	0.83	7.06	32.83
Obligate Upland Species	0.92	0.00	0.74	2.50
Other Species	2.50	0.28	4.41	6.00
Total	**25.18**	**82.22**	**114.12**	**136.67**

Notes:
"Indicator Status" refers to wetland indicator status for Region I wetlands.
"Indicator Status" Key:
OBL = Obligate Wetland
FACW = Facultative Wetland
FAC = Facultative
FACU = Facultative Upland
UPL = Obligate Upland
NI = No Indicator Status
Blank = Not included in the National List of Vascular Plant Species that Occur in Wetlands.
+ or - sign indicates a frequency toward higher or lower frequency of occurrence within a category.

These percentages are based on data from the 2003 summer sampling session.

Table 3
Vascular Plant Species Found at
Mill Creek Wetlands Mitigation Site
Hudson County, New Jersey
2003

Species List	Common Name	Indicator Status	Seasons Found	
			Spring	Summer
Ailanthus altissima	Tree of Heaven	FACU-	X	X
Amaranthus cannabinus	Saltmarsh Water Hemp	OBL	X	X
Ambrosia artemisiifolia	Ragweed	FACU	X	X
Andropogon gerardii	Big Bluestem	FAC-		X
Apocynum cannabinum	Indian Hemp	FACU	X	X
Artemisia vulgaris	Common Mugwort	UPL	X	X
Asclepias syriaca	Common Milkweed	FACU-	X	X
Aster subulatus	Annual Saltmarsh Aster	OBL	X	X
Atriplex patula	Orach	FACW	X	X
Baccharis halimifolia	Groundsel Tree	FACW	X	X
Barbarea vulgaris		FACU	X	
Betula populifolia	Gray Birch	FAC	X	X
Calystegia sepium	Hedge Bindweed	FAC-	X	X
Cerastium brachypetalum	Gray Chickweed		X	
Chenopodium album	White Goosefoot	FACU+	X	X
Chenopodium ambrosioides	Mexican Tea	FACU		X
Chenopoduim glaucum	Oak Leaved Goosefoot	FACW-	X	X
Cirsium arvense	Canada Thistle	FACU	X	
Cirsium vulgare	Bull Thistle	FACU-	X	X
Cirsium sp.				X
Convolvulus arvensis	Field Bindweed		X	X
Conyza canadensis	Horseweed	UPL	X	X
Cornus sericea	Red Osier Dogwood	FACW+	X	X
Cuscuta gronovii	Common Dodder			X
Cyperus strigosus	Straw-Color Flatsedge	FACW	X	X
Cyperus sp.			X	
Daucus carota	Wild Carrot		X	
Eclipta prostrata	Yerba-de-tajo	FAC	X	
Eleocharis parvula	Small Spikerush	OBL	X	X
Erechtites hieraciifolia	American Burn	FACU	X	X
Eupatorium album	White Bracted Eupatorium		X	X
Eupatorium serotinum	Late-Flowering Boneset	FAC-	X	
Festuca elaitor	Meadow Fescue	FACU	X	X
Festuca ovina	Sheep Fescue	NI	X	X
Fraxinus americana	White Ash	FACU	X	X
Hibiscus moscheutos	Swamp Rose-Mallow	OBL	X	X

Table 3
Vascular Plant Species Found at
Mill Creek Wetlands Mitigation Site
Hudson County, New Jersey
2003

Species List	Common Name	Indicator Status	Seasons Found	
			Spring	Summer
Hibiscus sp.			X	
Lactuca serriola	Prickly Lettuce	FAC-	X	X
Lepidium virginicum	Poor Man's Pepper	FACU-	X	X
Lycopus americanus	Water Horehound	OBL	X	X
Lycopus uniflorus	Northern Water Horehound	OBL		X
Lycopus sp.			X	X
Morus alba	White Mulberry	UPL	X	X
Oenothera biennis	Common Evening Primrose	FACU-	X	X
Oxalis stricta	Common Yellow Wood Sorrel		X	X
Oxalis sp.			X	
Panicum virgatum	Switchgrass	FAC	X	X
Phragmites australis	Common Reed	FACW	X	X
Phytolacca americana	Common Pokeweed	FACU+	X	X
Pluchea odorata	Saltmarsh Fleabane	OBL	X	X
Poa trivialis	Rough Blue Stem	FACW		X
Polygonum aviculare	Doorweed	FACU	X	X
Polygonum hydropiper	Water Pepper	OBL		X
Polygonum hydropiperoides	Swamp Smartweed	OBL	X	X
Polygonum pensylvanicum	Pennsylvania Smartweed	FACW		X
Polygonum persicaria	Lady's Thumb	FACW	X	X
Polygonum sp.			X	
Rhus aromatica	Fragrant Sumac		X	X
Rorippa palustris	Common Yellow Cress	OBL		X
Rumex acetosella	Common Sorrel	UPL	X	X
Rumex altissimus	Pale Dock	FACW-	X	X
Rumex crispus	Curly Dock	FACU		X
Rumex maritimus	Golden Dock	FACW		X
Rumex obtusifolius	Bitter Dock	FACU-	X	X
Rumex sp.			X	
Sambucus canadensis	American Elder	FACW	X	X
Schizachyrium scoparium	Little Bluestem	FACU-	X	X
Scirpus americanus	Olney's Bullrush	OBL	X	X
Setaria faberi	Nodding Foxtail	UPL		X
Setaria viridis	Green Foxtail		X	
Solanum dulcamara	Purple Nightshade	FAC	X	X
Solanum nigrum	Black Nightshade		X	X

Table 3
Vascular Plant Species Found at
Mill Creek Wetlands Mitigation Site
Hudson County, New Jersey
2003

Species List	Common Name	Indicator Status	Seasons Found	
			Spring	Summer
Solidago canadensis	Canada Goldenrod	FACU	X	
Solidago elliottii	Elliott's Goldenrod		X	X
Solidago rugosa	Wrinkled Goldenrod	FAC	X	X
Solidago sempervirens	Seaside Goldenrod	FACW	X	X
Sorghastrum nutans	Indian Grass	UPL	X	X
Spartina alterniflora	Saltmarsh Cordgrass	OBL	X	X
Taraxacum officinale	Common Dandelion	FACU-		X
Thlaspi arvense	Field Penny Cress	UPL	X	X
Verbena hastata	Blue Vervain	FACW+	X	
Zannichellia palustris	Horned Pondweed	OBL	X	

Notes:

"Indicator Status" refers to wetland indicator status for Region 1 wetlands.

"Indicator Status" Key:

OBL = Obligate Wetland

FACW = Facultative Wetland

FAC = Facultative

FACU = Facultative Upland

UPL = Obligate Upland

NI = No Indicator Status

Blank = Not included in the National List of Vascular Plant Species that Occur in Wetlands.

+ or - sign indicates a frequency toward higher or lower frequency of occurrence within a category.

Unknowns were excluded fom this list.

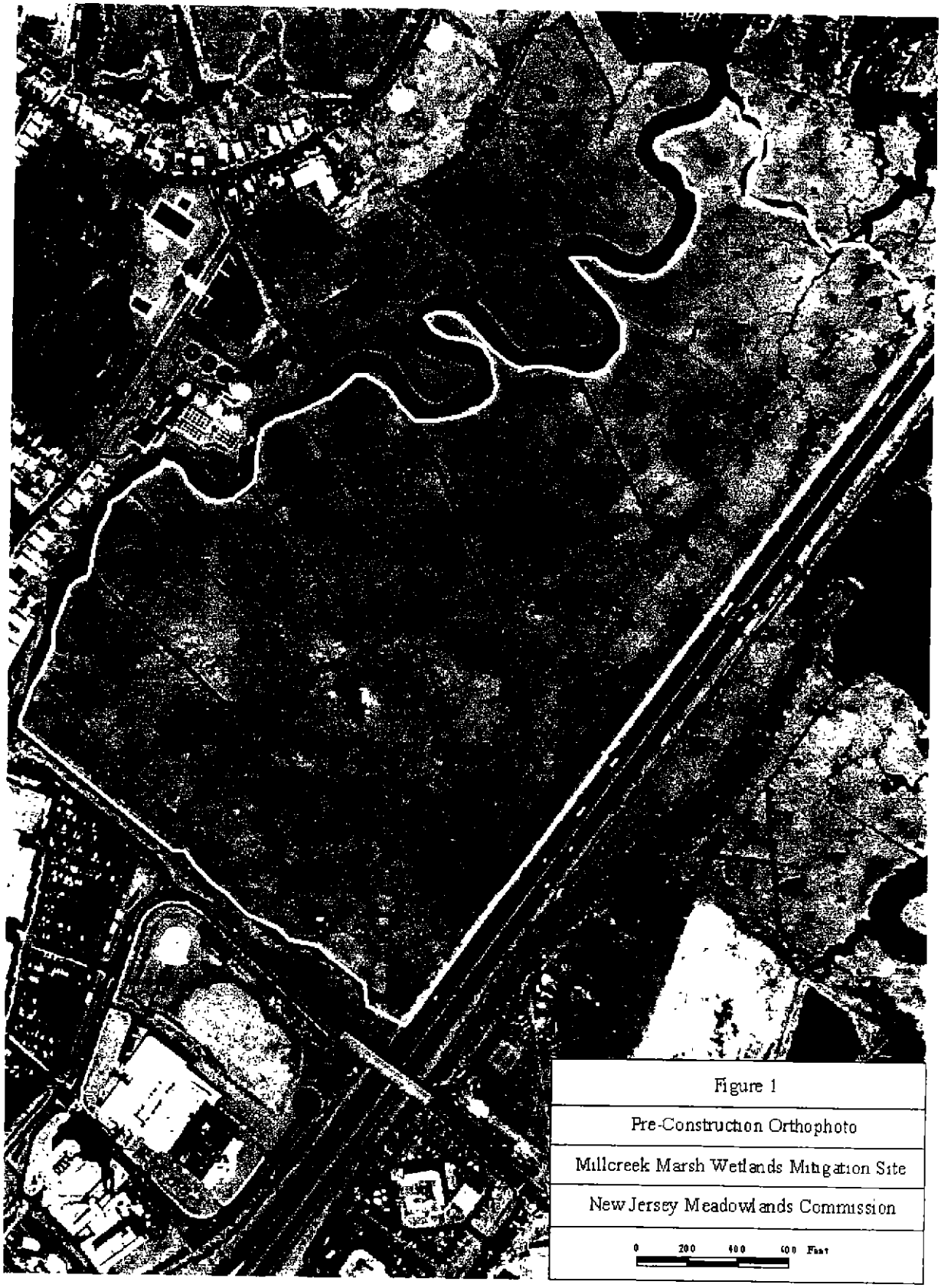


Figure 1

Pre-Construction Orthophoto

Millcreek Marsh Wetlands Mitigation Site

New Jersey Meadowlands Commission

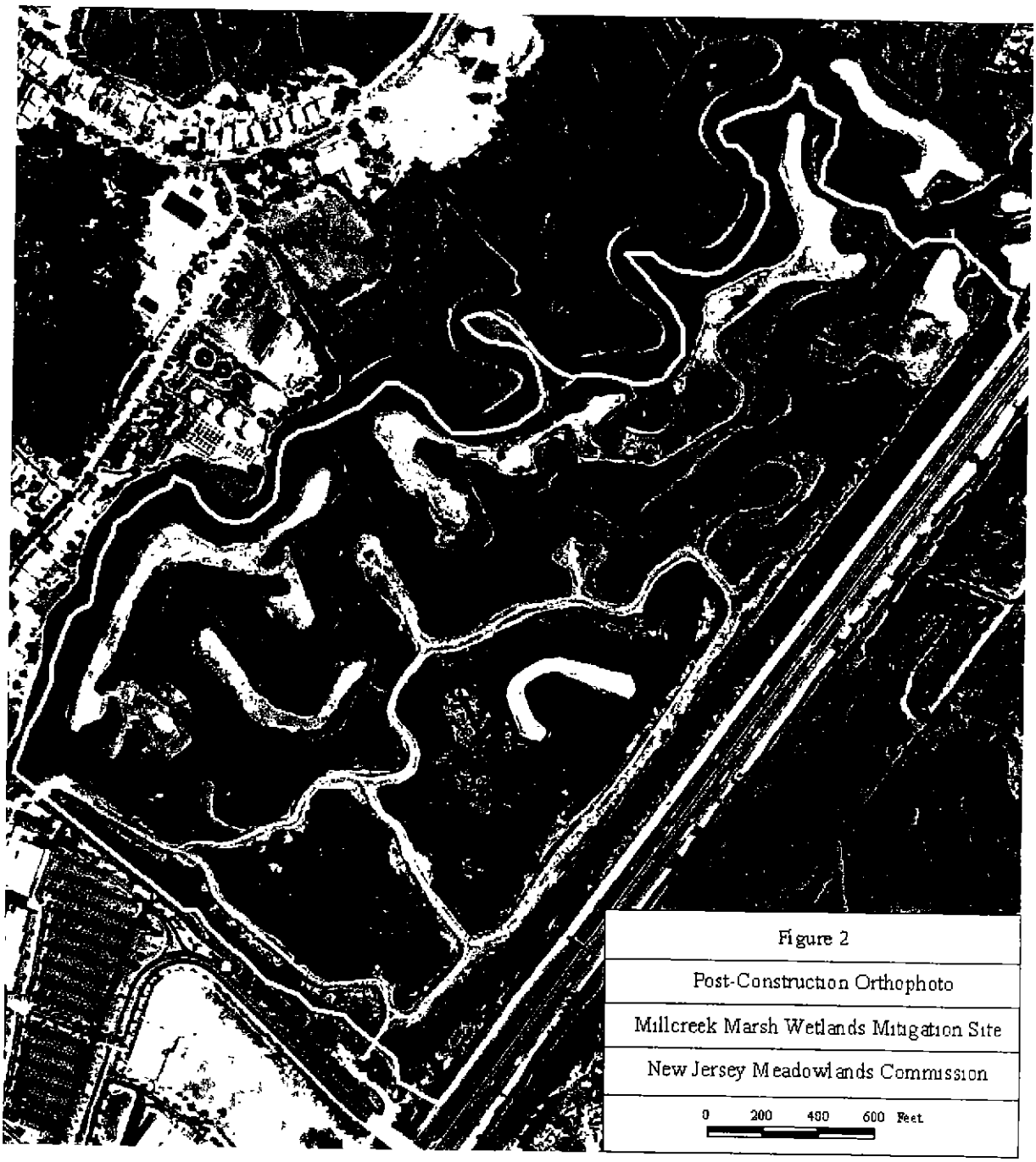


Figure 2

Post-Construction Orthophoto

Millcreek Marsh Wetlands Mitigation Site

New Jersey Meadowlands Commission

0 200 400 600 Feet

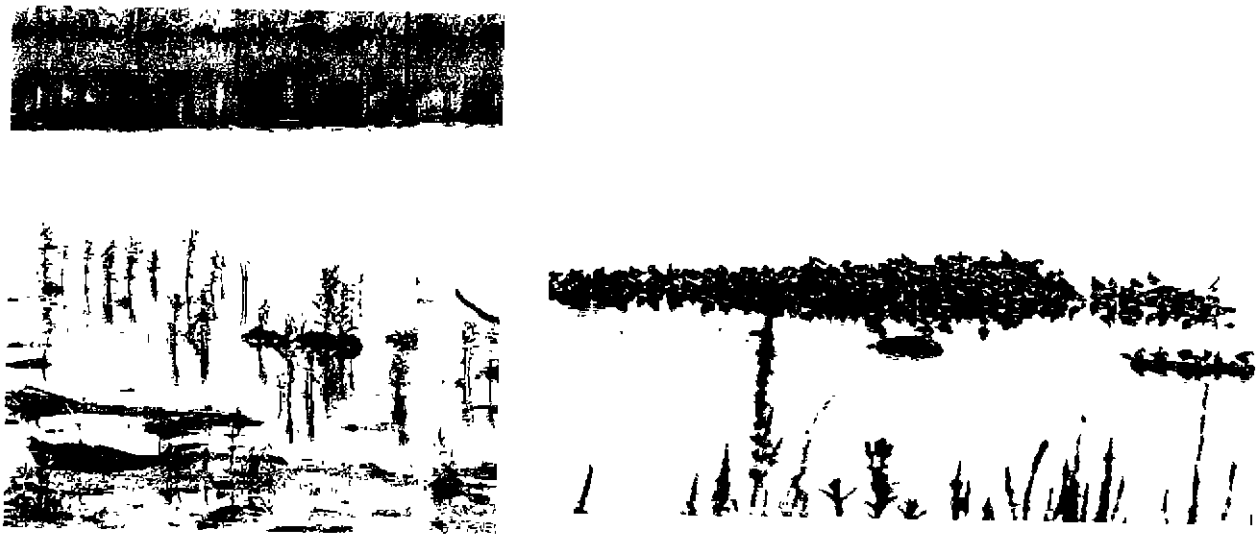


Figure 3. Wading and shorebirds using Mill Creek as foraging habitat.



Figure 4. Vegetation establishment patterns continued to be strong in the fourth growing season after construction was completed. The low and high marsh zones of Mill Creek were dominated by annual facultative and obligate wetland species.

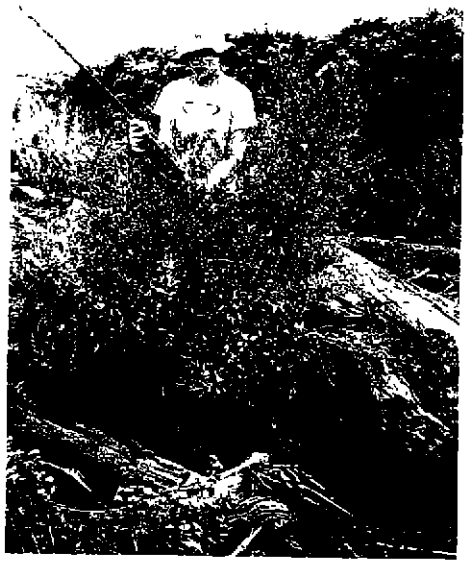


Figure 5. Experimental caging of small plots demonstrated that the grazing pressure from herbivores, such as Canada geese, was sufficient enough to inhibit the establishment and growth of some vascular plant species.





Figure 6. In 2002 and 2003, populations of *Zannichellia palustris*, an aquatic vascular plant, were found within the Site. Aquatic plants enhace the Site's ability to support healthy fish communities.



Figure 7. In June 2003, *Spartina alterniflora* was planted across approximately 5 acres of the low marsh zone at Mill Creek. Fences were established around the planted areas to protect the *Spartina* and other plants from herbivory. The 2001 and 2003 planting and fencing efforts have resulted in the successful establishment of *Spartina alterniflora* stands within Mill Creek.

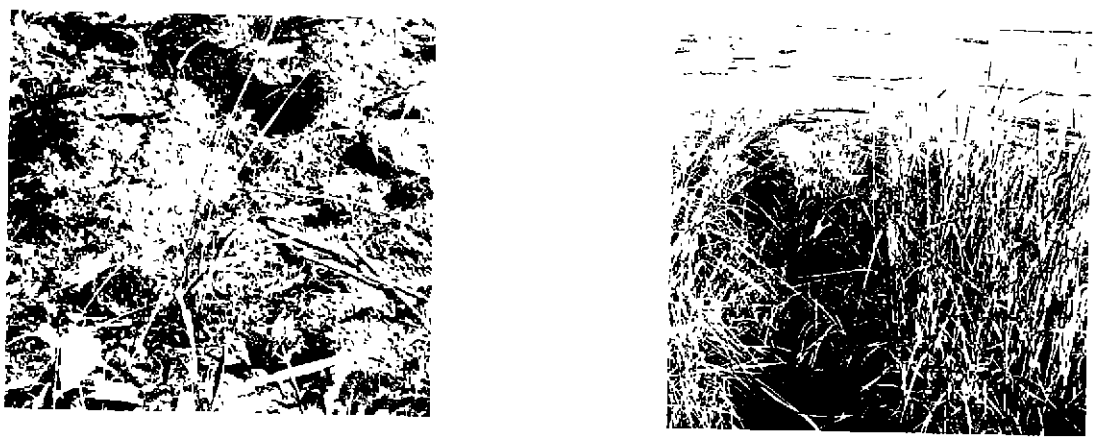


Figure 8. A 2003 *Spartina alterniflora* plug (left). With appropriate herbivory controls, stands of *Spartina* plantings from 2001 (right) have become established.