PARKS & RECREATION DEPARTMENT

TOWN OF ERIE

PROPOSAL FOR OPEN SPACE MANAGEMENT PLAN DEVELOPMENT AND LANDSCAPE TYPOLOGY IMPLEMENTATION

Submitted to:

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PROPOSAL FOR OPEN SPACE MANAGEMENT PLAN DEVELOPMENT AND LANDSCAPE TYPOLOGY IMPLEMENTATION

Project Understanding

Great Ecology is pleased to present a proposal to develop an open space management philosophy, approach, and site-specific management plans for Erie Parks & Recreation Department (Parks). Erie owns and manages a broad portfolio of park and open space properties, each with their own character and ecological value. As more people move to Erie and additional pressures begin to influence these areas it's important to understand the current make-up of the parcels and how best to manage each one to ensure ecological integrity is maintained. Great Ecology and our project team has worked with Denver Parks and Recreation (DPR) to implement a landscape typology approach to understand the make-up and function of their park portfolio, which then informs appropriate management actions. We propose developing a similar system for Erie's open space portfolio to develop a deep understanding of the managed landscapes and how best to protect them.

This scope of work has two general tracts: management plan development and landscape typology implementation. These tracts will occur concurrently and will build upon existing data to create a system that fully integrates the objectives of the Parks, Recreation, Open Space, and Trails Master Plan (PROST MP) and Natural Areas Inventory (NAI). Great Ecology will lead a team comprised of Cedar Creek Associates, Inc. and Adaptation Environmental Services, to develop a methodology which enables identification of landscape typologies, habitat sub-types, and associated hydrologic systems, as well as assessing and scoring certain qualitative parameters for each open space park to create site-specific management plans. This includes evaluating existing plant communities and wildlife habitat features as well as how the public is utilizing the area and any impacts that may be evident.

The objectives of this project are straight forward, but timing for completing the objectives is complicated by the fact we are at the end of the 2017 growing season. Therefore, to ensure progress can be made on the management plan and landscape typology implementation, we propose a prompt adaptation of the typology spectrum and approval of potential management issues followed by a rapid assessment of the open space portfolio. We also propose conducting a pilot scale implementation of the landscape typology to demonstrate its utility before full-scale implementation would be conducted during the 2018 growing season. This staggered approach allows us to capitalize on what remains of the growing season and advance the management plans in preparation of the 2018 growing season.

Development and implementation of the landscape typology and management planning, including development of the landscape typology methodology and geodatabase, open space portfolio evaluation, development of a management plan approach and site-specific management plans, as well as stakeholder coordination will be executed through seven concurrent and overlapping tasks:

Task 1: Data Synthesis and Stakeholder Coordination;

Task 2: Develop Typology Spectrum, Data Forms, and Monitoring Protocol;

Task 3: Management Plan Site Evaluations;

Task 4: Management Plan Development;

Task 5: Preliminary Typology Mapping and Field Validation;

Task 6: Data Processing, Geodatabase Finalization, and Quality Control; and

Task 7: Meetings and Project Management.

Task 1: Data Synthesis and Stakeholder Coordination

With all projects, it is important to understand available data to inform decision making and improve efficiencies while achieving project objectives. This project is no different. Since this project will build off the existing NAI database, it is especially important to review existing data, understand what currently exists on the landscape, and integrate that information into the typology spectrum. We will also review current maintenance standards and procedures to understand the current approach for land management. Our goal is to identify maintenance procedures that could be refined to save Erie time and money while improving the overall function and aesthetic of areas within the open space portfolio. It is imperative that the management plan be in alignment with the current PROST MP and the desires of current stakeholders.

Stakeholder Coordination

The management plan resulting from this contract will directly affect approximately 1,500 acres, with more to be added in the future. Many people and agency departments will be affected by this management plan, so it's important to make sure their concerns are understood early in the process. Developing a management plan that incorporates stakeholder objectives will best ensure stakeholder cooperation and implementation success. Stakeholders to be engaged through this task may include, but are not limited to:

- Erie Parks & Recreation Department, specifically Parks & Open Space Division;
- Open Space & Trails Advisory Board;
- Boulder Open Space and Mountain Parks;
- Irrigation ditch companies; and
- Urban Drainage and Flood Control District.

Additional stakeholders will be identified during the kick-off meeting to ensure we are working with all necessary parties to meet project objectives.

Potential Funding Partner

Urban Drainage and Flood Control District (UDFCD) is a potential stakeholder that Great Ecology will seek to engage during Task 1. A major effort is underway with UDFCD to identify and understand more effective stormwater management practices across their district, including Coal Creek. We are working with UDFCD as part of the DPR typology project and would recommend reaching out UDFCD as a potential project funding partner. We have already developed data forms for their data needs, so there is limited additional work needed to revise data forms or collect field data.

Task 1 Deliverables

Task 1 does not include true deliverables, as this is largely a research task to inform future decision making and deliverables. A kick-off meeting will be held during this phase of the project, but resources associated with that effort will be tracked in Task 7: Meetings and Project Management. During this task, we will want to ensure we have all necessary data, including any geographic information system (GIS) or computer aided design (CAD) files that are relevant to the properties we will be evaluating.

TASK 2: DEVELOP TYPOLOGY SPECTRUM, DATA FORMS, AND MONITORING PROTOCOLS

Task 2 will begin by developing an open space specific typology spectrum and revising the typology data forms to accommodate changes in the typology spectrum and integrating with existing NAI data. We will work with Parks personnel to refine the landscape typology spectrum template to accommodate specific landscape types that may be unique to Erie's open space portfolio. Data form revisions will include integrating relevant sections of Walsh's NAI inventories and as well as other relevant existing data gathered in Task 1.

Monitoring Protocols

A range of natural variability exists in ecosystems before a system is negatively impacted to the point that it no longer functions appropriately. We will develop a monitoring approach that categorizes the ecological health of each typology across each property. This approach will be designed to rapidly determine if an area is functioning, functioning at risk, or not functioning. This will require understanding where critical thresholds for ecological function exist and how to measure them.

Field validation and monitoring for each open space, therefore, is critical to the long-term success of this program. We will develop a monitoring strategy and protocol early in the planning phase to ensure we have an adequate understanding of the critical functions to be measured in the field. This will ensure consistent data collection that captures necessary information as efficiently as possible. Data collection procedures need to be easily understood and repeatable. The monitoring protocol may be refined as we move through the field validation and evaluation process, but having an early understanding of what will be required helps ensure efficient and cost-effective field work.

Task 2 Deliverables

Task 2 deliverables include:

- Revised Landscape Typology Spectrum;
- Integrated field data forms; and
- Brief memorandum describing the monitoring protocol and data to be collected.

The remaining tasks cover the two tracts mentioned above. Tasks 3 and 4 apply to management plans and Tasks 5 and 6 cover landscape typology. These concurrent tracts will build upon each other, to provide a system that allows Erie Parks & Recreation to effectively manage its open space properties.

TASK 3: MANAGEMENT PLAN SITE EVALUATIONS

Task 3 will focus on understanding the management issues for Erie Parks & Recreation and conducting a rapid assessment of open space properties so management plans can be developed in advance of the 2018 growing season. We will work with Parks personnel to develop a list of management concerns that need to be addressed on the ground and in the management plan. Once these concerns are identified and agreed to, we will conduct site visits to assess the condition of each open space property as it relates to the identified management issues, including assessing possible wildlife habitat and any associated management concerns.

Task 3 Deliverables

Deliverables for Task 3 include:

- Outlined list of management issues for inclusion in the management plan; and
- All data collected during site visits, including photos and field notes.

TASK 4: MANAGEMENT PLAN DEVELOPMENT

We will develop a management plan for Erie's open space properties based off data reviewed and collected as well as information and guidance gained from stakeholder meetings. This document will provide a management philosophy and approach as well as site-specific plans that address issues observed at each property. We propose the development of an adaptive management approach that allows flexible, yet responsive, actions to be implemented to ensure landscapes function appropriately.

Building off the ecosystem function thresholds identified in Task 2, we will develop appropriate management and maintenance actions that will help sustain or restore the desired ecological functions. This will be described for the entire open space portfolio and then tailored for each property. Because we want the management plan to be functional and applied, we will also develop a matrix that identifies management issues that need to addressed for each open space area. This matrix can provide an easy reference for maintenance personnel in the field.

We will develop the management plan, including individual property management plans, over the winter and spring of 2017/2018 and submit for review to Parks in spring of 2018. The management plan will then be updated and finalized following additional data collected as part of the landscape typology implementation in summer of 2018.

Task 4 Deliverable

Deliverable for Task 4 is a draft management plan document, including management matrix for maintenance crews.

TASK 5: PRELIMINARY TYPOLOGY MAPPING & FIELD VALIDATION

The purpose of preliminary mapping is to remotely map complex typologies and assign attributes based on aerial imagery to reduce the field work required. Data from preliminary mapping efforts will be entered into the geodatabase, which will be updated following field validation. Preliminary mapping will only include non-hardscape spaces, limited to areas within the landscape typology spectrum. We will perform initial typology mapping for five select parcels identified by Parks to provide a pilot demonstration of how this process works. The remaining open space areas will be evaluated in 2018.

Field validation and evaluation is critical to ensure data generated in this project provides Erie with the most accurate and useable data for managing parcels. Task 5 uses mapping and validates or modifies our assumptions through field evaluation of mapped typology polygons and completing field forms to further refine and collect qualitative and semi-quantitative data. As part of the evaluation, we will make additional observations and assessments of typologies, including updating inventories and identifying priority areas for restoration, landscape conversion, or environmental education.

Task 5 Deliverables

Task 5 deliverables will include:

- Interim version of the geodatabase and associated shapefiles from remote mapping of parcels; and
- Mapping and field validated data of properties completed as part of pilot project.

Task 6: Data Processing, Geodatabase Finalization, and Quality Control

This task will involve quality control and quality assurance on the geodatabase to ensure data integrity and provide Erie with properly formatted data that is consistent with data quality requirements. This will involve review of the database to identify missing information and fill in data gaps as part of finalization prior to delivery to Erie. Additional review and quality control of data will be performed to ensure data accuracy and proper formatting. This task includes data processing and GPS and geodatabase modifications based on field validation efforts.

Task 6 Deliverable

Deliverable for Task 6 is a final geodatabase and shapefiles for the complete Erie open space portfolio.

Task 7: Meetings and Project Management

This task is designated to track all meetings and coordination expected for completion of this project. Regular communication with the project team and agency project managers is integral to understanding progress and potential issues with the landscape typology program and management planning process. We anticipate nine meetings over the course of this project, approximately one per month. These meetings include:

- One project kick-off meeting;
- One Open Space & Trails Advisory Board Meeting at project outset;
- One meeting to discuss landscape typology spectrum and list of potential management concerns;
- One meeting to discuss field data form revisions and monitoring protocols;
- Progress meeting following completion of management plan site visits;
- Progress meetings following preliminary mapping and field validation efforts;
- Meeting to discuss maintenance recommendations; and
- Close-out meeting to present final deliverables, including geodatabase and management plan.

Other communications will take place and will be captured under this task, in addition to meetings listed above.

Task 7 Deliverable

The deliverable for this task is completion of the meetings identified above.

Fee Summary

Our fee is based on the projected work level required to complete all tasks. All work is billed on time and materials basis. If the actual cost of work reaches the budgeted fee, or if the scope of work changes, we will immediately inform you to request authorization to proceed.

Task	Budget ($)
Task 1: Data Synthesis & Stakeholder Coordination	**8,520**
Task 2: Develop Typology Spectrum, Data Forms, & Monitoring Protocol	**11,880**
Task 3: Management Plan Site Evaluations	**15,460**
Task 4: Management Plan Development	**20,700**
Task 5: Preliminary Mapping & Field Validation	**45,410**
Task 6: Data Processing, Geodatabase Finalization, & Quality Control	**8,420**
Task 7: Meetings & Project Management	**10,630**
Labor Subtotal	**121,020**
Other Direct Costs	**1,188**
Total	**122,208**

Great Ecology will initiate work immediately upon receipt of written authorization to proceed. Great Ecology invoices monthly for its services.

Assumptions

We developed the proposal and fees with the following assumptions:

- Project management costs are included in the task fees;
- Erie Parks & Recreation will provide all GIS, CAD, and NAI data for review and use as well as any other relevant data that may inform management plan development or open space portfolio evaluations;
- All meetings were assumed to include up to two Great Ecology staff and require two hours each for meeting preparation, attendance, and follow-up actions. Cedar Creek and Adaptation Environmental are only expected to attend half the meetings identified;
- We will assess up to 1,500 acres as described to encompass the current Erie open space portfolio. Additional parcels can be added to this proposal as part of a separate scope or increased fee;
- Field work is weather dependent and may affect our ability to complete the proposed scope within the proposed schedule. If significant weather or contracting issues prevent us from keeping the proposed schedule, we will coordinate with Erie Parks Director to change the scope of work, project schedule, or both, depending on circumstances.
- The deliverables included in this proposed estimate will be submitted in digital ArcGIS or PDF/Microsoft Word format; the costs for hard copies and large format prints are not included.

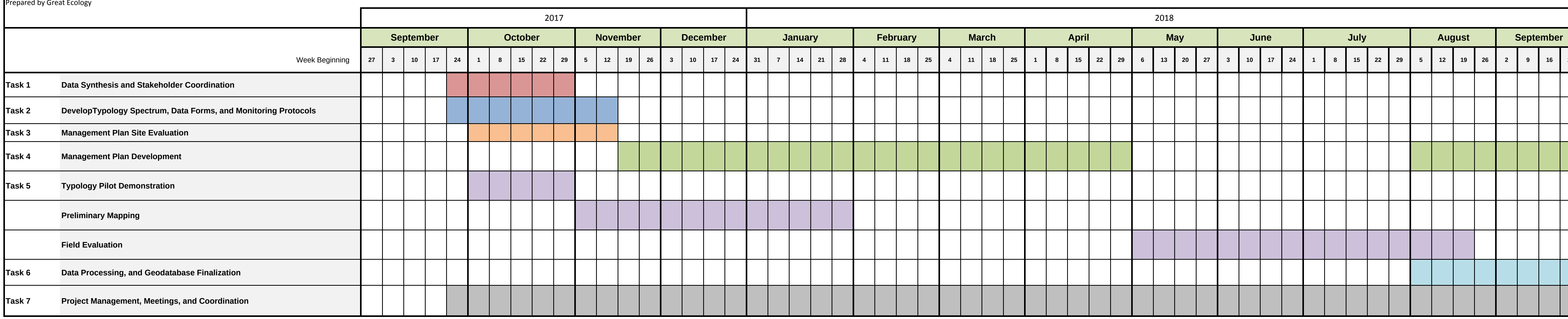
Schedule

This proposed schedule is preliminary. If Erie requires an alternate timeline, Great Ecology will make every effort to accommodate the desired schedule. Figure 1 provides a proposed calendar to complete the proposed scope of work.

Exhibit 1: Proposed Schedule for Project Completion

9/11/2017

Prepared by Great Ecology



WORK PRODUCT EXAMPLES FOR LANDSCAPE TYPOLOGY AND ADAPTIVE MANAGEMENT PLAN

Native Systems

LANDSCAPE TYPOLOGIES

	Divisions	Upland Systems			Riparian Systems		Hydrologic Systems			
	Landscape Type	Upland Forested	Upland Herbaceous	Disturbed Area	Riparian Forested	Riparian Herbaceous	Herbaceous Wetland	Surface Water		
	ERO Type			X			X			
	Characterization	Forest dominated ecosystem comprised of minimum 35% total canopy cover of trees and native herbaceous, shrub or mixed understory (non-bluegrass dominated).	Grass and forb dominated ecosystem. Trees represent less than 35% of total canopy cover.	Herbaceous, non-turfgrass upland plant communities with less than 25% total cover or 25% or greater total cover consisting of invasives. Transitional areas that should be prioritized for restoration.	Riparian woodland or shrubland ecosystems associated with streams, lakes, and ponds. Tree canopy cover greater than 35% total cover with herbaceous understory.	Riparian grass and forb ecosystem associated with stream, lake, or pond buffer areas with less than 35% total cover by trees and shrubs. For lakes, this area extends from the shoreline outward at least 30 feet. For streams, this area extends from the oridnary high water mark to areas that transition to upland vegetation, typically 10-20 feet.	Herbaceous dominated wetland with groundwater inflows and organic soil accumulation.	All surface water, including streams, drainage ditches, and open water ponds and lakes, including and below the ordinary high water mark.		
GIS Attributes	Hydrologic System	NA	NA	NA	**Drainage Channel**; **Stream Armored** (Visible rip-rap or other stabilization features); **Stream Unarmored** (Minimal to no stabilization features); **Open Water**	**Drainage Channel**; **Stream Armored** (Visible rip-rap or other stabilization features); **Stream Unarmored** (Minimal to no stabilization features); **Open Water**	NA	**Drainage Channel** (Irrigation ditch or other constructed conveyance channel that would not exist if not man-made.)	**Streams** (armored and un-armored stream channels that would naturally drain an area.)	**Open Water** (Pond or lakes that are generally non-wetland areas.)
	Habitat Sub-Type	NA	Native short-grass prairie; Native mixed-grass prairie; Shrubs (Greater than 35% total cover); Non-native herbaceous (Greater than 50% total cover of non-native species)	NA	Cottonwood (Greater than 50% total cover by cottonwood); Mixed woodland (diverse, no single species greater than 50% total cover); Willow (Greater than 50% total cover by willow); Non-native (Greater than 50% total cover by non-native trees)	Native (Greater than 50% total cover of native species); Non-native (Greater than 50% total cover of non-native species)	Native (Greater then 50% total cover native species); Non-native (Greater than 50% total cover non-native species)	Concrete-lined; Armored; Un-armored	Concrete-lined; Armored; Un-armored	NA
	Irrigation	Non-irrigated; Irrigated: Potable, Non-Potable	Non-irrigated; Irrigated: Potable, Non-Potable	Non-irrigated; Irrigated: Potable, Non-Potable	Non-irrigated; Irrigated: Potable, Non-Potable	Non-irrigated; Irrigated: Potable, Non-Potable	NA	NA	NA	NA
	Maintenance Level	Yellow	Yellow	Yellow	Yellow	Yellow	Green/Blue/Yellow	Green/Blue/Yellow	Green/Blue/Yellow	Green/Blue/Yellow
	Maintenance Activity	Weed control, Debris removal, Tree management	Weed control, Debris removal, Irrigation, Mowing	Weed control, Debris removal, Revegetation	Weed control, Debris removal; Tree management	Weed control, Debris removal, Mowing	Weed control, debris removal	Weed control, Debris removal	Weed control, Debris removal	Weed control, Debris removal
Feature Attributes	Ecological*	**Regulating Services** (erosion protection, water purification) **Supporting Services** (nutrient cycling, primary production, wildlife habitat)	**Regulating Services** (erosion protection, water purification) **Supporting Services** (nutrient cycling, primary production, wildlife habitat)	**Regulating Services** (erosion protection, water purification)	**Regulating Services** (erosion protection, water purification) **Supporting Services** (nutrient cycling, primary production, wildlife habitat)	**Regulating Services** (erosion protection, water purification) **Supporting Services** (nutrient cycling, primary production, wildlife habitat)	**Regulating Services** (erosion protection, water purification) **Supporting Services** (nutrient cycling, primary production, wildlife habitat)	**Some Pollution Mitigation** or attenuation. Patches of medium to low quality habitat	**Freshwater stream services** and habitat. Riparian services and habitat. Wildlife movement.	**Freshwater habitat.** Wildlife stopover and foraging. Stormwater conveyance and mitigation.
	Aesthetic	Native landscape aesthetic with heterogeneous topography, plant community, and increased structural diversity. Provides wildlife habitat and tree canopy viewscape.	Native landscape aesthetic with heterogeneous topography and plant community. May exhibit wildlife habitat elements.	Native landscape aesthetic with heterogeneous topography and plant community. May exhibit wildlife habitat.	Native herbaceous buffer for stream systems. Woodland areas provide functional riparian habitat and greater structural vegetation appearance.	Native herbaceous buffer for stream systems. Functional herbaceous cover provides stream system support and visual enhancement.	Urban wildlife refugia within park and open spaces. Enhance habitat function and visual diversity on landscape.	Linear water conveyance	Urban stream systems with ecological functions and water conveyance. Freshwater systems provide visual and functional complexity.	Pond or lake systems with ecological functions and water storage. Freshwater systems provide visual and functional complexity.
	Citizen Usage	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate

*Ecological services presented are illustrative and do not capture the full suite of services offered by these habitat types.

Anthropogenic Areas

				Developed Areas Included for Reference, but Covered Under DPR Planning, Design, + Construction Standards						
Divisions		Traditional Park Spaces					Developed Areas			
Landscape Type		Bluegrass Forested	Bluegrass Lawn	Parkway	Athletic Field	Planting Areas	Dog Parks	Trail	Playgrounds	Developed and Park Features
ERO Type			X					X		X
Characterization		Tree canopy cover greater than 35% with bluegrass lawn understory.	Irrigated bluegrass fields largely free of trees or facilities.	Tree lawns and vegetated medians along boulevards, could be native or horticultural species.	Turf grass area intended for organized sports with or without facilities.	Annual or perennial planting beds within park space, row, or similar.	Gravel or sand/soil, limited vegetation, specifically intended for off-leash activities.	Paved or soft surface hiking or biking trail.	Developed playground areas.	Buildings, facilities, parking lots, picnic shelters, etc.
GIS Attributes	Hydrologic System	NA	NA	NA	NA	NA	NA	NA	NA	NA
GIS Attributes	Habitat Sub-Type	NA	NA	NA	NA	Annual; Shrub; Combination; Roses; Perennial; Annual/Perennial	NA	NA	NA	NA
GIS Attributes	Irrigation	Non-irrigated / Irrigated (Potable / Non-Potable)	Non-irrigated / Irrigated (Potable / Non-Potable)	Irrigated	Irrigated	Irrigated	NA	NA	NA	NA
GIS Attributes	Maintenance Level	Green/Blue	Green/Blue	Blue	Green/Blue	Blue	Green/Blue	Green/Blue	Green/Blue	Green/Blue
Maintenance Activity		Mowing, Irrigation, Weed control, Overseeding, Facility maintenance, Tree management	Mowing, Irrigation, Weed control, Overseeding	Mowing, Irrigation, Weed control, Overseeding	Aeration, Overseeding, Mowing Irrigation Weed control, Facilities Maintenance (e.g. soccer goals)	Flower bed prep and maintenance, Soil prep, Planting, Pruning, Mulching	Soft surface maintenance, Weed control	Snow removal, Weed control	Fall zone material, Site inspections	General maintenance
Feature Attributes	Ecological*	**Regulating Services** (erosion protection, water purification)	**Regulating Services** (erosion protection, water purification)	**Regulating Services** (erosion protection, water purification)	**Some Regulating Services** (infiltration, erosion protection, temperature maintenance)	**Regulating Services** (infiltration, erosion protection, water purification) Wildlife benefits	**Some Regulating Services** (infiltration, reduced runoff compared to hardscape)	Soft surface trail has **Some Regulating Services** (infiltration)	Minimal Ecological Support	Minimal Ecological Support
Feature Attributes	Aesthetic	Passive park space with groves of trees	Urban turf grass park areas with active and passive recreation	Passive lawn and treed space for visual enhancement along roadways	Provide recreational amenity and added greenspace within urban or developed areas	Isolated planting area for visual enhancements in existing parks, row, or vegetated areas	Active use area integrated into park spaces, specifically for off-leash area	Active use within existing park space	Built environment for active use	Built environment for active use
Feature Attributes	Citizen Usage	High	High	Medium to Low	Very High	Moderate	High	Very High	Very high	Very high

*Ecological services pre

LANDSCAPE TYPOLOGY FIELD DATA SHEET

Park:	Loc_Code:	Typology:	Habitat Subtype:
Observer	Date:	Irrigation: None / Potable / Non-Potable	Photo - Y / N

Total Vegetation Cover by Strata		Dominant Species 1	Cover	Dominant Species 2	Cover	Noxious Weeds 1	Noxious Weeds 2	
Tree	%		%		%			%
Shrub	%		%		%			%
Forb	%		%		%			%
Grass	%		%		%			%

GENERAL QUALITATIVE PARAMETERS	Excellent	Good	Fair	Poor	N/A	COMMENTS
A. Diversity of Species (N/A for traditional park spaces)	4	3	2	1	X	
B. Wildlife	4	3	2	1	X	
C. Overall Aesthetic	4	3	2	1	X	
D. Ecological Connectivity	4	3	2	1	X	
Sustainability						
E. User-defined Trails	4	3	2	1	X	
F. Improper Uses	4	3	2	1	X	

MAINTENANCE QUALITATIVE PARAMETERS	None	Minor	Moderate	Major	N/A	
G. Noxious Weed Population Description	4	3	2	1	X	
H. Visual Water Quality (excluding upland typologies)	4	3	2	1	X	
I. Annual / Invasive Weed Population Description	4	3	2	1	X	
J. Opportunities for Restoration (Describe in comments)			Y / N			
Total Score						

STREAM CHARACTERISTICS (Stream Areas Only)	Excellent	Good	Fair	Poor	N/A	
K. Root Depth (Feet)	4	3	2	1	X	
L. Root Density (Percent)	4	3	2	1	X	
M. Surface Protection (Percent)	4	3	2	1	X	
N. Bank Angle (Degrees)	4	3	2	1	X	
O. Bank Height		Feet				

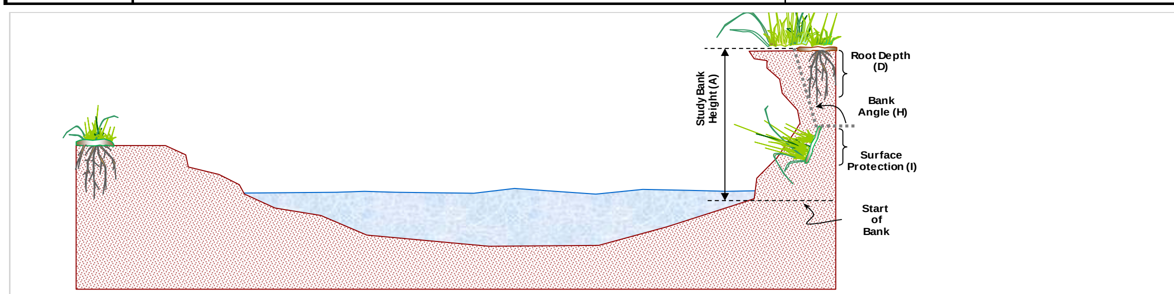
P. Flow Regime	Intermittent	Ephemeral	Perennial	N/A
Q. Bank Material (Type)	Bedrock	Boulders	Riprap	Gravel
	Sand	Silt/Clay	Concrete	N/A

Possible Ecosystem Services:

Other Comments:

LANDSCAPE TYPOLOGY FIELD DATA SHEET		
GENERAL QUALITATIVE PARAMETERS		
Diversity of Species (N/A for traditional park spaces)		
4	**Excellent**	Landscape contains high species richness (number of species per unit area) and evenness (relative abundance of the different species making up the richness of an area) relative for that specific habitat type.
3	**Good**	Landscape contains intermediate levels of species richness and evenness relative for that specific habitat type.
2	**Fair**	Landscape contains low levels of species richness and evenness relative for that specific habitat type.
1	**Poor**	Landscape contains a monoculture of either a native or nonnative species.
N/A	**N/A**	Not applicable
Wildlife		
4	**Excellent**	Landscape contains high quality habitat to support multiple wildlife types. Multiple wildlife habitat features are present such as cover, food sources, breeding areas, and protective elements.
3	**Good**	Landscape contains good quality habitat to support multiple wildlife types. Wildlife habitat features are present but not abundant.
2	**Fair**	Landscape contains moderate habitat to support some wildlife. Habitat features are limited, and wildlife present not likely to be diverse.
1	**Poor**	Landscape contains little to no wildlife habitat. Landscape is either degraded or habitat is not present to support wildlife.
N/A	**N/A**	Not applicable
Overall Aesthetic		
4	**Excellent**	Landscape is integrated into the surrounding spaces and neighborhood. The landscape contains visually appealing structural and landscape diversity and complexity associated with topography, scenic views, and vegetation (trees, shrubs, planting beds and ground cover). If occurring, park facilities complement the overall design of the landscape.
3	**Good**	Landscape is integrated into the surrounding spaces and neighborhood. The landscape contains some structural and landscape diversity and complexity; however, the landscape is lacking visually appealing scenic views and vegetation. If occurring, park facilities complement the overall design of the landscape.
2	**Fair**	Landscape is not integrated into the surrounding spaces and neighborhood. The landscape is lacking adequate structural and landscape diversity and complexity. Some planting beds and trees are present. If occurring, the park facilities do not complement the overall design of the landscape.
1	**Poor**	Landscape is not integrated into the surrounding spaces and neighborhood. The landscape does not contain visually appealing structural and landscape diversity and complexity associated with topography and vegetation (trees, shrubs, planting beds and ground cover). Scenic views are unavailable to users. If occurring, the park facilities do not complement the overall design of the landscape.
N/A	**N/A**	Not applicable
Ecological Connectivity		
4	**Excellent**	The park is highly connected to other elements of the larger park system and/or is in close proximity to trails; presence of outfalls or confluences in riparian or open water systems; similar park features (i.e. trees, shrubs, open water areas); and/or there is a general absence of barriers such as walls, roads, large urbanized areas, and dams.
3	**Good**	The park is moderately connected to other elements of the larger park system and/or is in relative proximity to trails; similar park features (i.e. trees, shrubs, open water areas); and/or there is a relative absence of barriers such as walls, roads, large urbanized areas, and dams. May have presence of outfalls or confluences in riparian or open water systems.
2	**Fair**	The park is somewhat connected to other elements of the larger park system and/or has minimal proximity to trails; similar park features (i.e. trees, shrubs, open water areas); and/or there are moderate barriers such as walls, roads, large urbanized areas, and dams. May lack presence of outfalls or confluences in riparian or open water systems.
1	**Poor**	The park is disconnected to other elements of the larger park system and/or has no proximity to trails; similar park features (i.e. trees, shrubs, open water areas); and/or there are moderate to significant barriers such as walls, roads, large urbanized areas, and dams. Lacks presence of outfalls or confluences in riparian or open water systems.
N/A	**N/A**	Not applicable
Sustainability		
Sustainability - User Defined Trails		
4	**Excellent**	There are no user-defined trails.
3	**Good**	There are limited user-defined trails and/or the user-defined trails can be integrated into the landscape with minimal impact to the local ecosystems.
2	**Fair**	There are multiple user defined trails that show limited to moderate use and/or any user-defined trail shows signs of moderate landscape degradation.
1	**Poor**	There are multiple user defined trails that show limited to frequent use and/or any user-defined trail shows signs of moderate to servere degradation, including, but not limited to erosion.
N/A	**N/A**	Not applicable
Improper Uses		
4	**Excellent**	There is no evidence of improper or unauthorized uses, which may include, but are not limited to: improper trash disposal; debris on trails or walkways, presence of temporary recreational activities; etc.
3	**Good**	There is some evidence of improper or unauthorized uses, which may include, but are not limited to: improper trash disposal; debris on trails or walkways, presence of temporary recreational activities; etc. These uses are not actively degrading the landscape.
2	**Fair**	There are moderate improper or unauthorized uses, which may include but are not limited to: improper trash disposal; presence of pet waste; presence of temporary spaces for recreational activities; etc. These uses are causing some degradation of the landscape.
1	**Poor**	There are moderate to significant improper or unauthorized uses, which may include but are not limited to: improper trash disposal; presence of pet waste; presence of temporary or permanent spaces for recreational activities; use of off-road vehicles; presence of improper shelters; many user-defined trails; etc. These uses are causing moderate to severe degradation of the landscape.
N/A	**N/A**	Not applicable
MAINTENANCE QUALITATIVE PARAMETERS		
Noxious Weed Population Description		
4	**None**	No noxious weeds present.
3	**Minor**	The site is composed of less than 5% noxious weeds.
2	**Moderate**	The site is composed of between 5% and 20% noxious weeds.
1	**Major**	The site is composed of greater than 20% noxious weeds.
N/A	**N/A**	Not applicable
Water Quality (excluding upland typologies)		
4	**None**	High water clarity characterized with no visible suspended solids, no evident algal blooms, dense and undisturbed riparian buffer, adequate hydraulic flow, and no trash or debris.
3	**Minor**	Visible suspended solids within the water table, evidence of algal blooms, riparian buffer with little evidence of impairment, adequate hydraulic flow, and little trash and/or debris evident within system.
2	**Moderate**	Visible suspended solids within the water table, evidence of algae blooms, impaired riparian buffer, no hydraulic flow, and trash and/or debris evident within system.
1	**Major**	Poor water clarity characterized with high levels of suspended solids, increased presence of algal blooms, no riparian buffer, no hydraulic flow, and high volume of trash and/or debris.
N/A	**N/A**	Not applicable
Signs of User-Caused Degradation		
4	**None**	No user degradation.
3	**Minor**	The landscape contains few trampled vegetated areas showing no clear unauthorized trails, small amounts of trash scattered around the receptacles from passive littering, and little to no evidence of vandalism. Evidence of user degradation is less than 10% of the landscape.
2	**Moderate**	The landscape contains defined unauthorized trails, exposed bare ground is forming in high traffic areas, trash scattered around the receptacles from passive littering, and vandalism is evident on structures within the landscape. Evidence of user degradation is between 10% and 30% of the landscape.
1	**Major**	The landscape contains extensive user degradation including many unauthorized trails and parking areas, exposed bare ground, high amounts of trash scattered throughout the landscape from both active and passive littering, and extensive evidence of vandalism. Evidence of user degradation is greater than 30% of the landscape.
N/A	**N/A**	Not applicable
Annual / Invasive Weed Population Description		
4	**None**	No annual or invasive weeds present.
3	**Minor**	The site is composed of less than 25% annual or invasive weeds.
2	**Moderate**	The site is composed of between 25% and 50% annual or invasive weeds.
1	**Major**	The site is composed of greater than 50% annual or invasive weeds.
N/A	**N/A**	Not applicable
	Total Score	
	36 -27	High quality landscape features with limited need for improvement or changes to maintenance required.
	26 -17	Medium quality landscape features with moderate need for improvements and maintenance requirements.
	16-7	Low quality landscape features with high need for improvements and maintenance requirements.
	less than 7	Poor quality landscape features with immediate need for improvement and maintenance intervention.

STREAM CHARACTERISTICS			
Root Depth (Feet)			
4	**Excellent**	Average root depth is greater than or equal to 3 ft deep	Represents average depth of roots of riparian vegetation. Choose an area that appears representative of the steam segment, or where roots are visible. Determine root depth by observing areas of visible roots or removing soil to expose roots. Measure representative roots and determine average in feet.
3	**Good**	Average root depth is between 1 ft to 3 ft deep	
2	**Fair**	Average root depth is between 0.5 ft to 1 ft deep	
1	**Poor**	Average root depth is less than or equal to 0.5 ft deep	
N/A	**N/A**		
Root Density (Percent)			
4	**Excellent**	100 to 80 percent of the stream bank is occupied by roots of riparian vegetation	Represents the proportion of the stream bank above bankfull that is occupied by roots of riparian vegetation. Choose an area that appears representative of the steam segment, or where roots are visible. Assess areas of visible roots or use excavation and determine proportion of roots relative to soils, and calculate as a percentage.
3	**Good**	55 to 79 percent of the stream bank is occupied by roots of riparian vegetation	
2	**Fair**	15 to 54 percent of the stream bank is occupied by roots of riparian vegetation	
1	**Poor**	Less than 14 percent of the stream bank is occupied by roots of riparian vegetation	
N/A	**N/A**		
Surface Protection (Percent)			
4	**Excellent**	100 to 80 percent of the stream bank is occupied by protective materials	Represents the proportion of the stream bank surface, at or below bankfull, that is occupied by roots, woody material, rocks, or other protective material. Choose an area that appears representative of the steam segment. Assess areas of visible roots, or use excavation, and determine proportion relative to soils. Calculate as a percentage.
3	**Good**	55 to 79 percent of the stream bank is occupied by protective materials	
2	**Fair**	15 to 54 percent of the stream bank is occupied by protective materials	
1	**Poor**	Less than 14 percent of the stream bank is occupied by protective materials	
N/A	**N/A**		
Bank Angle (Ratio)			
4	**Excellent**	Slope gradient is less than or equal to 4:1 (14 degree angle)	The measurement of the angle of the bank from the lower bank, approximately at the waterline, to the top of the stream bank. Choose a representative area and measure the angle of the bank from the waterline to the top of the stream bank. Approximate the angle of the bank or use an inclometer.
3	**Good**	Slope is between 4:1 and 2:1 (14 degrees to 27 degrees)	
2	**Fair**	Slope is between 2:1 and 1:1 (27 degrees to 45 degrees)	
1	**Poor**	Slope is greater than or equal to 1:1 (45 degree angle) or is a cut slope	
N/A	**N/A**		
Bank Height			
Feet (actual)		Choose an area that appears representative of the segment of stream being assessed. Determine the upper limit of the stream bank and measure the vertical distance to bankfull, in feet.	Represents the difference between the upper limit of the stream bank and the toe (start of the bank) at bankfull. The top of the stream bank is generally the upper level of riparian vegetation. The start of the bank may be below waterline.
Flow Regime			
Perennial		Water flowing continuously year-round	Classification of streams based on parameters such as magnitude, frequency, duration, timing, and rate of change of flow. Identify flow regime as either perennial, ephemeral, or intermittent.
Intermittent		Water flowing seasonally (wet season); Normally dry during summer	
Ephemeral		Typically shallow; Normally dry with brief periods of flow in response to rainfall	
N/A			
Bank Material (Type)			
Bedrock		Naturally occurring solid rock foundation	Choose a representative area of the stream segment and visually assess bank materials, or excavate soils if needed, and indicate most dominant material.
Boulders		Large rounded stones	
Riprap		Course aggregate with angular shapes	
Gravel		Fine to course aggregate up to 1 inch in diameter	
Sand		Course well drained soil	
Silt/Clay		Fine soils	
Concrete		Channel completely lined with cement	
N/A			



MILSTEIN (PHIL) PARK TYPOLOGIES

DENVER PARKS AND RECREATION
AUGUST 2017

0 75 150 300 FEET

Loc_Code 911
NAD83 HARN_StatePlane_CO_Central_FIPS_0502_Feet

GREATecology
ENVIRONMENT + DESIGN

PLATTE RIVER AT ELITCH GARDENS TYPOLOGIES

DENVER PARKS AND RECREATION
AUGUST 2017

0 75 150 300 FEET

South
Loc_Code 926
NAD83 HARN_StatePlane_CO_Central_FIPS_0502_Feet

GREATecology
ENVIRONMENT + DESIGN

CHERRY CREEK PARK TYPOLOGIES

DENVER PARKS AND RECREATION
AUGUST 2017

0 125 250 500 FEET

Northwest Side
Loc_Code 330
NAD83 HARN_StatePlane_CO_Central_FIPS_0502_Feet

GREATecology
ENVIRONMENT + DESIGN

ADAPTIVE MANAGEMENT PLAN

WOODBRIDGE WATERFRONT PARK

EPEC POLYMERS, INC.

JULY 2013

GREAT ecology
ENVIRONMENT + DESIGN

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1 INTRODUCTION AND PROJECT BACKGROUND

This Adaptive Management Plan (AMP) is a requirement of the state and Federal permits issued by the New Jersey Department of Environmental Protection (NJDEP), Permit No. 1225-02-0016.4 Condition 41, and the United States Army Corps of Engineers (USACE) for remediation and mitigation of the Former Nuodex Corporation Facility (Fords property), owned by EPEC Polymers, Inc. (EPEC); an adjacent property to the west (Fords II), owned by Ashland Oil and Refining Company, Inc. (Ashland); and two parcels owned by Woodbridge Township in the southern portion of the Fords property. These combined properties—approximately 190 acres—will comprise the Woodbridge Waterfront Park (hereafter, collectively referred to as the Site).

Great Ecology, on behalf of EPEC, has developed this AMP to formalize a process in response to unexpected events and uncertainties that may arise and affect the success of the mitigated and constructed habitats onsite. The scope of the AMP includes onsite remedial activities addressing contamination in soil, surface water, sediments, and groundwater. The AMP also addresses onsite wetland mitigation for impacts to existing wetlands and open waters resulting from the implementation of the remedial action.

This AMP details the procedures to be used as this project shifts from design and construction to operations and maintenance activities. These procedures are designed to maintain permit compliance by meeting or exceeding the structural and functional success criteria set forth by the NJDEP and USACE.

1.1 HISTORY AND RATIONALE FOR ADAPTIVE MANAGEMENT

Adaptive Management (AM) as a theory and application became widely accepted by the mid-1990s (Lee 1993; Ogden and Davis 1994; Collier et al., 1997), although the idea was first presented in 1978 (Holling 1978). Since then, project managers have found it to be a useful tool to adjust to the changing conditions and uncertainties associated with large-scale restoration projects like this one. Adaptive management has proven so successful that in 2007, the United States Congress required that all ecosystem restoration projects approved by the USACE have AMPs developed as part of their permit conditions (WRDA 2007, Section 2039). Additionally, the NJDEP has included adaptive management as part of the project specific permit conditions.

Great Ecology will use this AMP, which also includes monitoring and experimentation techniques to address critical questions, as the process by which data on key uncertainties will be generated, analyzed, distributed, and incorporated into project decision-making. The result is a better-informed and continuingly improving restoration project.

1.2 Baseline/Reference Area Summary

In 2009, Great Ecology conducted a detailed ecological survey of the Site to understand the current conditions and guide the restoration objectives. We surveyed the level of functionality of the wetlands and surrounding upland habitats and reported on wetland quality and the potential impacts to the biota, habitats, and ecological function from planned remedial, restoration, and redevelopment activities. We compiled the findings into the Ecological Synthesis Report (Great Ecology 2010a), which informed the determination of suitable and appropriate resource valuations and ultimate mitigation requirements for planned remedial and developmental activities. The following are the major findings of the Ecological Synthesis Report, which formed the basis of the Site restoration goals:

- Both wetland functional assessments (Wetland Evaluation Technique [WET] and Evaluation of Planned Wetlands [EPW]) indicated a generally low level of function on the Site with regards to fish and wildlife habitat and aquatic diversity and abundance, and low values for recreation, uniqueness, and heritage.
- Onsite wetlands function well with respect to groundwater recharge effectiveness, sediment stabilization, flood protection, sediment/toxicant retention, and nutrient removal/ transformation—functions typically ascribed to large, vegetated, depressional wetland complexes adjacent to a flood-prone river.
- There was a low interspersion of classes in the vegetative structure largely the result of historic land alteration and deemed the largest contributor to reduced onsite wetland functionality.
- Vegetation and benthic macroinvertebrate communities were comprised of primarily disturbance-tolerant and/or invasive species.
- Most of the onsite plant species were native, but invasive and introduced species comprised half of the biomass production. This indicated dominance by a small number of non-native plant species, primarily *Phragmites australis* (common reed, hereafter Phragmites).
- Based on Indicators of Biological Integrity (IBIs) generated from benthic macroinvertebrate survey data, the ponds and Central Wetlands were considered to contain *moderately impaired* benthic macroinvertebrate communities.
- Nearly 100 species of birds were observed; however, there was a fairly low avian and amphibian species occurrence as compared to the number of possible species for the Site. There was limited onsite breeding as compared to species assemblages occurring in similar habitats regionally. However, this is typical of the Lower Raritan watershed, which has

experienced habitat degradation from urbanization of the larger regional landscape.

- Faunal species occurrence is likely the result of migration rather than reproduction, underscoring the Site's potential as future breeding habitat once restored.

The Ecological Synthesis Report specifically identified the following mitigation restoration activities likely to increase ecological and wetland functionality of the Site:

- Removing Phragmites;
- Replanting with a variety of native plants (including species that will result in a complex vegetative strata and attract wildlife);
- Interspersing of restored wetland and upland features;
- Creating open water habitat more suitable for fish;
- Improving hydrological flow; and
- Enhancing open areas to public access and/or recreation, when and where feasible.

This baseline information from the Ecological Synthesis Report informed the restoration planning for the Site and provides a point of comparison for monitoring results as construction is completed. Meeting or exceeding the performance standards will determine project success, and this AMP is designed to help manage any changes required to meet performance standards.

1.3 Project Goals and Objectives

Following the baseline evaluation, Great Ecology, in compliance with state and federal mitigation standards, developed the project goals and objectives to replace and enhance wetland functions and values lost as a result of the implementation of the Remedial Action Work (RAW) Plan.

Great Ecology will mitigate for permanent, unavoidable impacts by enhancing existing degraded wetlands to a highly functioning complex matrix of wetland habitats. Riparian mitigation includes extensive eradication of invasive species and establishment of native vegetation communities. Upon project completion, the Site will support regional restoration project goals, including those of the Harbor Estuary Program (HEP) and the Sustainable Raritan River Collaborative (SRRC). These project objectives include:

- Establishment of target habitats (open water, emergent marsh, emergent pond, forested wetland, tidal salt marsh, and required riparian transition areas);
- Establishment of plants and hydrophytic vegetation to 85% cover and 85% survival rate in wetlands and riparian areas;

- Establishment of suitable wetland hydrology (gauged by water level monitors, onsite observations, and hydric soils); and
- Eradication and reduction of invasive species to less than 5% aerial cover in the mitigated areas.

Great Ecology will semi-annually monitor functional performance objectives using the Wetland Evaluation Technique (WET) and the Evaluation for Planned Wetlands (EPW) functional assessment methodologies. The functional performance objectives include:

- Replacement and enhancement of wetland functions and values (sediment stabilization, fish and wildlife habitat, floodflow alteration, sediment/toxicant retention, nutrient removal/ transformation, aquatic and wildlife diversity, as well as uniqueness/heritage, and recreation values);
- Establishment of suitable foraging and resting habitat for state-listed species; and
- Public access to the mitigation area and Raritan River.

These goals and objectives outline the desired final outcomes for the Site and this AMP will help achieve these goals by providing an effective feedback loop for the performance and management of the Site. We describe specific performance standards in Section 2.1.

1.4 Habitat Descriptions

Great Ecology proposed habitats that are complex and dynamic to maximize onsite ecological diversity and meet the desired objectives for the Site. There are 11 different habitats that have either been created or exist onsite, and each one serves a different function and purpose. This also means that there are different recovery trajectories for each one. Great Ecology developed an extensive Mitigation Monitoring Plan (MMP) (Great Ecology 2013) to help track and evaluate the progress of each of the mitigated or constructed habitats to ensure that each habitat is meeting the Site performance objectives in the expected timeframe. We developed this AMP to work in conjunction with the MMP to provide a process for evaluation and management of habitats when a deficiency is identified during monitoring. The following maps (FIGURES 1 and 2) and habitat descriptions (APPENDIX A) are included so that Great Ecology field staff and management teams are familiar with all habitats encountered onsite and so that management actions can appropriately respond to what is needed for each habitat type.

FIGURE 1: SITE MAP (1 OF 2)

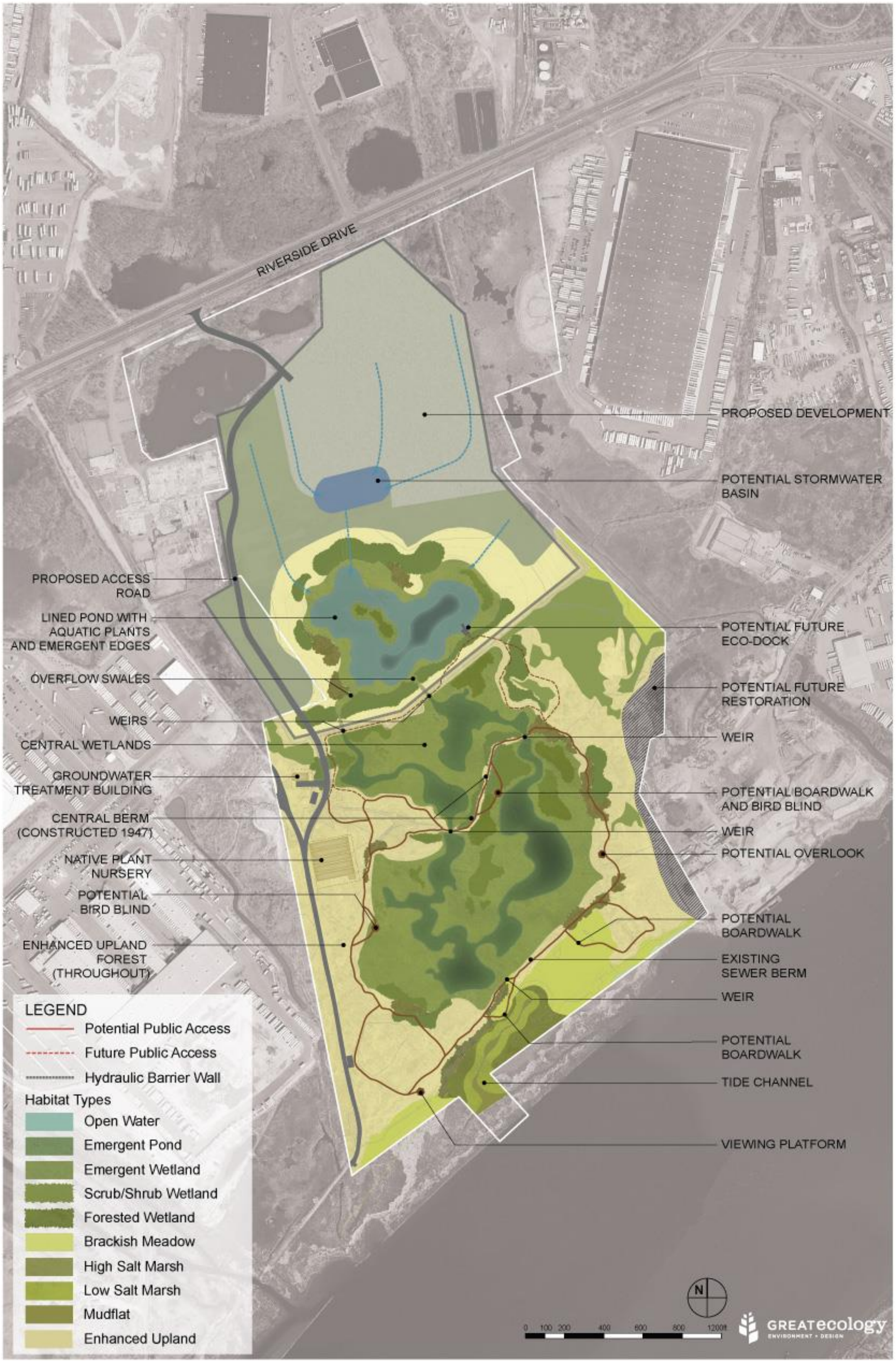


FIGURE 2: SITE MAP (2 OF 2)

1.5 ADAPTIVE MANAGEMENT ORGANIZATIONAL STRUCTURE

The Project Management Team (PMT) is comprised of EPEC, Great Ecology, Brown and Caldwell, and USA Environment, LP (USA) (FIGURE 3). THE PMT has collaborated to ensure EPEC achieves the project objectives outlined in the approved permits. The PMT responds to USACE and NJDEP, but EPEC approves actions based on recommendations from the PMT. It is important to note that the structure of the PMT changes when Site construction is complete, which is scheduled for September 2015 (FIGURE 4). At this time, engineering and construction support is no longer needed; Great Ecology becomes solely responsible for monitoring and making AM recommendations to EPEC.

1.5.1 Adaptive Management Roles and Responsibilities

- **EPEC:** Property owner and final decision maker;
- **Brown and Caldwell:** Engineering support, design, stamp engineering, and construction specifications;
- **USA Environment, L.P.:** General Contractor responsible for remediation activities and implementing restoration actions, heavy equipment operations;
- **Great Ecology:** Environmental consultant, conducting environmental surveys, drafting permit applications and revisions, provides construction oversight, environmental monitoring, data analysis, and reporting.

FIGURE 3: PMT (CONSTRUCTION)

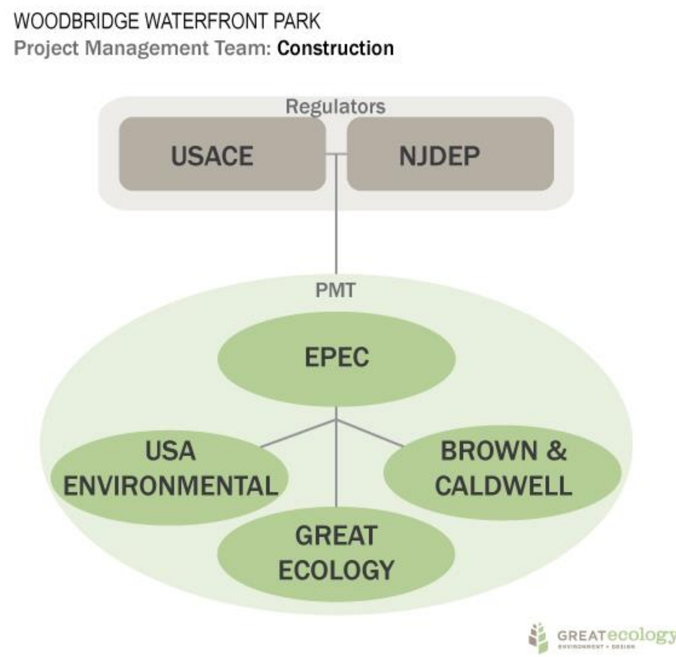
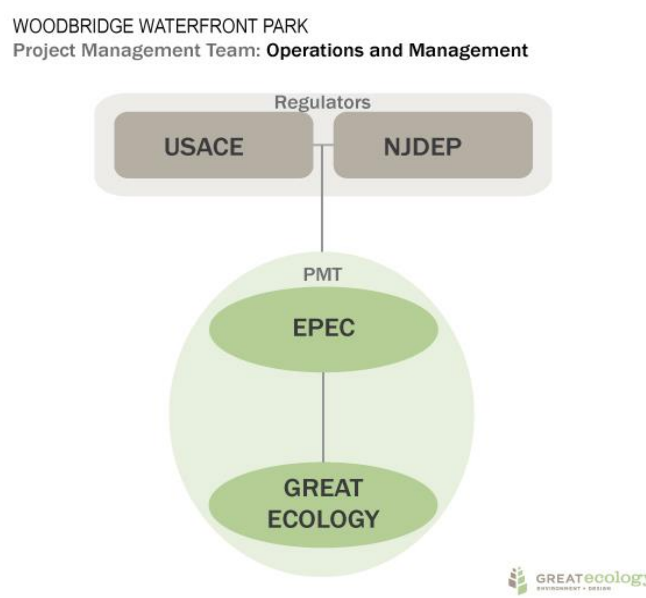


FIGURE 4: PMT (OPERATIONS AND MANAGEMENT)



1.5.2 Adaptive Management Interactive Process

Effective adaptive management planning requires an interactive process that allows field-verified data to be expeditiously shared with the PMT to ensure decisions are made quickly, changes are initiated, and the project stays on schedule and meets all success requirements. The adaptive management process we are initializing and describing in this report applies to the monitoring phases of the Woodbridge Waterfront Park Project. The applied studies and management plans described in Section 2.4 detail the adaptive management process we used during the construction phases.

FIGURE 5: SAMPLE ADAPTIVE MANAGEMENT PROCESS

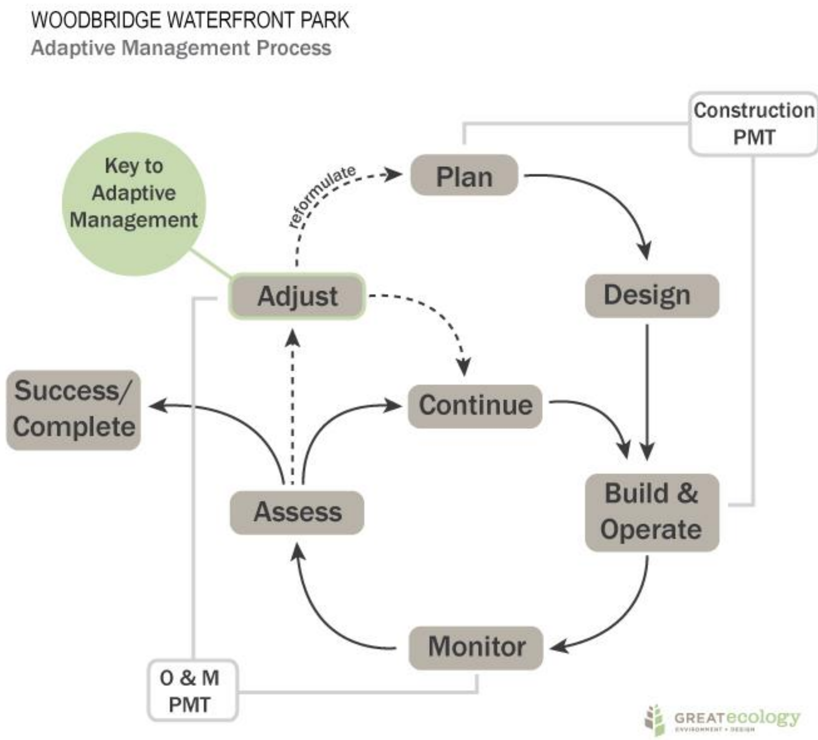


FIGURE 5 depicts an example of how the adaptive management process works, beginning with the planning and design stages, followed by construction and operations, and then monitoring, which initiates the AMP described herein. Great Ecology is responsible for conducting the environmental monitoring following construction.

Monitoring events are scheduled to take place four (4) times during the growing season and include invasive species monitoring, fauna and infauna evaluations, vegetation and soils monitoring, and wetland functional assessments. We will relay the results and observations from these events to EPEC by means of written and oral reports no less than once annually. These reports will guide internal discussions among PMT members to determine what, if any, adjustments and corrective actions are needed. If corrective action requires regulatory approval, the PMT will develop an appropriate strategy and plan of action before engaging regulators or other public stakeholders. Any changes made by the PMT to the existing construction or management specifications will be integrated into future phases of the project. If corrective action does not require regulatory approval, such as weed control or reseeding, the PMT will request that EPEC approve a qualified contractor to carry out the corrective action.

2 ADAPTIVE MANAGEMENT PROCESS

This AMP is designed to address concerns associated with the monitoring phase of this project to ensure that the mitigation is successful. We assume the adaptive management required during the remediation and construction phases will be addressed by the RAW and the appropriate Construction Quality Assurance Protocol (CQAP). Additionally, to anticipate project uncertainties, Great Ecology instituted and documented monitoring procedures and performed in-depth research studies of the Site. These proactive initiatives include the Invasive Species Removal and Control Plan (ISRCP), the Site-Wide CQAP, the Mitigation Monitoring Protocol, the Wetland Test Plots Analysis, and the Upland Pilot Study.

2.1 PERFORMANCE SUCCESS STANDARDS

Great Ecology defines project performance success in three categories: Regulatory, Functional, and Landscape.

2.1.1 Regulatory Success

We define Regulatory Success as fulfilling specific permitting requirements following five (5) years of post-construction monitoring. These requirements include:

- 85% native plant cover, where specified;
- Less than 5% aerial cover of invasive species in wetland mitigation areas;
- Acreage of restored, enhanced, and created wetlands (as determined by hydrophytic vegetation, hydric soils, and wetland hydrology), as specified in the mitigation design; and
- Establishment of a planted upland buffer/wetland transition area around the perimeter of mitigated areas.

2.1.2 Functional Success

We define Functional Success as the replacement and enhancement of wetland functions and values onsite. Functional success standards include:

- Documented site usage by amphibians, birds, reptiles, fish, and invertebrates determined by primary and secondary observations (for example, observation of egg masses, nests, tracks, scat);
- Improved Wetland Functional Assessment scores from existing onsite conditions (Wetland Functional Analysis Report, 2010b); and
- The establishment of onsite public access to the Raritan River.

2.1.3 Landscape Success

Landscape success is meeting regional restoration goals, such as those documented in the HEP Comprehensive Restoration Plan or those of the SRRC. The HEP CRP is a collaborative plan developed by Federal agencies, including the United States Environmental Protection Agency (EPA) and USACE, and non-governmental organizations focused on ecological restoration in the larger Hudson-Raritan Estuary region. The SRRC was formed in early 2009, when a group of concerned citizens joined staff from Rutgers University to create an action plan to restore and preserve the Raritan River watershed in compliance with the Federal Clean Water Act. A major goal of the SRRC is reconnecting citizens with the Raritan River by increasing public access and recreation—a key objective of the Woodbridge Waterfront Park.

2.2 Key Uncertainties and Applied Studies

We anticipate there will be uncertainties and issues to be addressed during the construction and monitoring phases. Known key uncertainties include:

- The full aerial extent of contamination;
- The effectiveness of the revegetation procedures given the density and extent of Phragmites and other invasive species onsite (for example, *Ailanthus altissima*, *Artemesia vulgaris*);
- The functional abilities and ecological health of the wetlands; and
- The recovery lag time for each of the functional groups (for example, vegetation communities, soils, hydrology, and wildlife habitat).

2.2.1 Invasive Species Removal and Control Plan

A top priority of state and Federal regulators is minimizing invasive species. At least 67 acres of wetlands and uplands in the central and southern portions of the Site are dominated by *Phragmites*. There also are significant areas of woody invasive plants onsite, including large trees such as *Ailanthus altissima, Paulownia tomentosa*, and *Populus alba;* woody shrubs (*Lonicera* spp., *Rosa multiflora*); and herbaceous material (*Alliaria petiolata, Artemesia vulgaris, Polygonum cuspidatum*, *Persicaria perfoliata*) that require eradication to meet permit compliance conditions.

There is a Site-wide requirement of <5% invasive species cover for the life of the project during the post-planting monitoring phase.

Great Ecology recognizes that this goal is only achievable with a well-organized, sound plan and the ability to execute it. The Invasive Species Removal and Control Plan (ISRCP) (provided in APPENDIX B) is a reference guide for removing Site-wide invasive species, recognizing invasive species re-colonization, and establishing protocols for treatment and removal through post-construction and maintenance/monitoring phases. Removal procedures include both chemical and mechanical treatment options with repeated applications during a minimum of three (3) years. We will monitor invasive species removal and control success as a critical part of our 5-year compliance monitoring program as well as during adaptive management site walks and other onsite activities.

2.2.2 Site-Wide Construction Quality Assurance Protocol

The Site-Wide Construction Quality Assurance Protocol (CQAP) (USA 2011) includes a presentation of activities and quality assurance protocols to facilitate clear, accurate, and organized performance of compensatory mitigation construction. Additionally, each specific construction area, (e.g., Central Wetlands) has a site-specific CQAP that includes a more detailed description of the required protocol for adaptive management before commencement of construction and remediation activities.

The Site-wide CQAP documents the procedures and processes to ensure successful construction of mitigation areas in compliance with permit requirements, including the identification of issues or deficiencies that may impact the project schedule or fail to meet success criteria. The Site-wide CQAP meets the following objectives:

- Verifies that project work meets or exceeds design, regulatory, and permit requirements;
- Establishes quality procedures and an organizational structure to ensure project work is performed in accordance with design requirements and industry standards;
- Describes guidelines for inspection, sampling, and documentation of construction and mitigation activities;
- Describes how unexpected changes of conditions that may impact construction activities will be detected, documented, and addressed;
- Enhances work quality through the use of standardized procedures; and
- Promotes project efficiency and cost savings.

2.2.3 Wetland Test Plots

Great Ecology implemented the Wetland Test Plots in 2012 to determine if we could modify the invasive species mitigation procedure to effectively control invasive species and yield potential cost savings.

We created a series of treatments that investigated the effect of different depths of soil excavation (and subsequent growth medium replacement) and different densities of planted species on the control of invasive species. We were able to run the experiment for only one growing season because of the effects of Hurricane Sandy. However, the results from this series of experiments indicated that we could reduce the excavation depth from 18 to 12 inches and still adequately control *Phragmites.*

This finding would have been a significant cost savings for EPEC, but unfortunately the approved permit had set the required excavation depth at 18 inches.

2.2.4 Upland Pilot Study

Great Ecology also initiated an Upland Pilot Study in 2013 to test remediation procedures for the upland habitats. There was concern that the specified procedures would not adequately control *Phragmites* and that discing the uplands may actually increase *Phragmites* regeneration. We also wanted to find out if adding woody species would effectively limit *Phragmites* reinvasion and if adding live plugs of grass species would significantly improve cover. Great Ecology designed a series of experiments to evaluate the effects and use of discing, woody species, and live plugs to meet cover standards and control *Phragmites*. This pilot study has only recently been installed (July 2013); thus, there are no results available at this time. We will use the results to appropriately modify the upland reclamation procedures if there is sufficient empirical evidence to support changes.

2.3 Monitoring Plan To Track Restoration Progress

Great Ecology has developed a Mitigation Monitoring Plan (MMP) (Great Ecology 2013) to evaluate the overall function and success of the project. The MMP is a critical adaptive management tool used to effectively track and evaluate the progress of Site development semi-annually. Using the MMP, Great Ecology identifies and documents instances where the project is not meeting applicable standards and remediates them as soon as possible. In addition to the formal sampling procedures to be carried out in late spring and summer (TABLE 1), we also will conduct regular site walks looking for evidence of erosion, stagnant water, and patches of invasive species that may have been missed during the vegetation surveys. We will photograph, document, and record GPS coordinates of any area of concern.

TABLE 1: MONITORING SCHEDULE

	2013						2014						2015						2016					
	Apr	May	Jun	Aug	Sep	Oct	Apr	May	Jun	Aug	Sep	Oct	Apr	May	Jun	Aug	Sep	Oct	Apr	May	Jun	Aug	Sep	Oct
WFA					✔		✔					✔	✔					✔	✔					✔
Veg Mon.					✔				✔		✔				✔		✔				✔		✔	
Fauna/ Infauna	✔				✔			✔						✔						✔				
Invasive Sp. Mon.	✔			✔			✔			✔			✔			✔			✔			✔		

Great Ecology designed the MMP to adequately monitor the 11 constructed or mitigated wetland and upland habitat types (APPENDIX A) in compliance with all applicable permit requirements.

Great Ecology will monitor these habitat types for vegetation cover, invasive species, hydric soil development, hydrology, water quality, and use/occupancy of fauna and infauna.

Great Ecology will collect the vegetation, soil, and hydrology data using a grid pattern based on the site grid established by USA. We will associate fixed photo point stations with each sampling point to document vegetation and habitat change over time. We will ensure that all habitat types have at least one sampling location, but the total number of samples collected will depend on the area completed and the total area of each habitat type. Additionally, we will perform wetland functional analyses in the spring and fall to evaluate and document functional improvements to those habitat types.

The animal and invertebrate samples will be more closely linked to the location of surface waters or overall site conditions because animals are mobile and do not typically rely on a single habitat type. **It should be noted that our recommended procedures are flexible and can be easily modified if the required data cannot be collected in a timely or effective manner.**

The data we collect will be stored in a database on a secure server that will function as a long-tern data repository. The database will be searchable by resource metric, year, and location. We will analyze and compare field data against both baseline data and approved success standards and schedules to evaluate and document changes in function and ensure we meet the success standards on schedule. We will present these results and evaluations in the annual monitoring reports submitted to EPEC and ultimately to the NJDEP and USACE following each growing season. If the data indicates additional remediation is required, this information will be relayed expeditiously to the PMT so the area of concern can be quickly addressed.

We also are required to inspect compensatory mitigation areas for damage in the event of severe storms, floods, drought, or other destructive events to ensure that damage is documented and plans for repair and debris removal are implemented at the earliest possible opportunity. If repair, debris removal, or other actions are required, we will document the area with photographs, written descriptions, and GPS coordinates, as necessary. Potential contingency measures include:

- Plant additional vegetation/reseed;
- Weed control;
- Substrate amendment;
- Modify water inlet/outlet controls;

- Supplemental surface water inputs/irrigation;
- Grading revision;
- Erosion control;
- Replacing/repairing missing or damaged structures;
- Spot control and removal of Phragmites and other invasive species; and
- Add supplemental wildlife attractors/forage plant species.

2.4 Adaptive Management Feedback Loop

The most important part of the AMP is the feedback loop. PMT members ensure identified deficiencies are effectively communicated and addressed immediately. As shown in FIGURE 5, the feedback loop is focused on results. Great Ecology will conduct regularly scheduled monitoring events and report back to EPEC as soon as possible on any findings that may require attention. The PMT will decide the proper course of action. If the management action is a simple procedure, like invasive species treatment/control, then EPEC is likely to approve the action, and Great Ecology will inform the subcontractor on the species and areas requiring treatment. If the management action is more serious, such as reseeding a large area, and may require additional planning or even a permit modification, the PMT will be expanded to include the necessary stakeholder, such as Brown and Caldwell and/or USA. The PMT will then develop the necessary corrective plan of action and submit that plan to EPEC and then to USACE and NJDEP, as needed. If the permit change is approved, EPECC will determine who is the appropriate subcontractor to perform the corrective action. It should be noted that we do not anticipate large-scale changes to the mitigation plan once construction is complete.

The elapsed time from the identification of a deficiency to when the PMT is notified should not exceed 48 hours, if at all possible. This response time is necessary given the requirement to rapidly correct any identified issue. Moreover, timing is critical in these matters to ensure the highest level of project success.

3 PROJECT RISK FACTORS, CRITICAL THRESHOLDS, AND PROPOSED MANAGEMENT ACTIONS

There are many uncertainties and risks associated with restoration projects of this magnitude in this geographical region. The following subsections describe risks that can disrupt the project timeline and affect project success. In addition, we define the metrics that will be monitored and the threshold values that will trigger corrective action.

3.1 PROJECT RISK FACTORS AND CRITICAL THRESHOLDS

The Project Risk Factors Matrix (TABLE 2) details potential issues that may be encountered during the lifetime of the mitigation project, potential adaptive management solutions, as well as the parties responsible for implementation of management actions. Each project risk factor and resultant management action identified in TABLE 2 is further detailed in this section and discussed in the order from most to least likely to occur.

3.1.1 Invasive Species

Invasive species reoccurrence onsite is the most likely project risk factor to occur, despite the rigorous ISRCP. This is due to the surrounding sources of invasive species on neighboring properties, the existing seed bank, among other reasons. Permit conditions require that less than 5% of aerial cover be derived from invasive species to be deemed successful. Therefore, during vegetation assessments twice a growing season and during site walks, we will evaluate the presence and cover of invasive species with trigger points to determine if control efforts are necessary to prevent re-establishment. As a general rule during cover evaluations along an individual sampling transect or habitat type evaluation:

- If Phragmites contributes greater than 1% cover, we will flag that area for repeated evaluation at the next sampling event,
- If Phragmites contributes greater than 5% cover, we will flag that area for spot herbicide treatment,
- If Phragmites contributes greater than 25% cover, we will flag that area for widespread herbicide treatment and possible mowing,
- If Phragmites contributes greater than 50%, we flag the area for mowing and herbicide treatment with potential for soil removal and replacement.

These threshold categories will help us define the extent of re-establishment of invasive species on the Site and provide an objective measure of success compared to the regulatory standards. If a threshold is triggered, we will treat the affected area as soon as possible considering the appropriate treatment timeframe for the species of concern and the approved herbicide for treating that species.

TABLE 2. POTENTIAL PROJECT RISKS

Potential Risks	Action Threshold	Potential Solutions	Solution Initiator	Responsible Party to Act	Specification or Resource
Invasive Species	>5% aerial coverage of invasive/noxious species per sampling area	Apply additional herbicide; physical removal; increase vegetative density during replant	Great Ecology	USA/Subcontractor	Invasive Species Removal and Control Plan (ISRCP, Appendix B)
Pests/Wildlife: Deer—Waterfowl—Insects	Damage or failure of deer fencing or goose mesh, wildlife/pest damage observed onsite	Repair goose mesh/deer fencing as-needed	USA and Great Ecology	USA/Subcontractor	Deer Fence; Goose Fence
	Onsite observations present evidence of a pest/wildlife issue interfering with plant establishment/growth in mitigation areas	Unexpected wildlife/insect problems to be addressed if/when they arise; replanting of damaged plant material; change plant palette	USA		
Drought	Plant available moisture, as measured by a soil-moisture probe, is 40-60% of field capacity.	Irrigation; replant	Great Ecology	USA	Irrigation Plan/Water Management Plan (to be developed)
Flood	Contingency inspections directly after large storms and follow up visit several days later to determine onsite conditions	Temporary condition? Dewater, re-grade, replant	USA	USA/Subcontractor	Irrigation Plan/ Water Management Plan (to be developed)
		Permanent/Semi-permanent condition? Change plant palette, re-grade, replant	Great Ecology		
Open Water Pond Stagnation	Algae observed > 5 m^2 area, stagnant odor, dissolved oxygen levels below 5.0 mg/l, dead fish, prolonged dry period (drought)	Remove accumulated organic material; pulse hydrology/filling pond; algaecide; barley straw; aeration of pond in critical areas	Great Ecology	PMT Team	Final Design Drawings for Open Water Pond
Wrack/Ice Scour (Tidal Marsh)	Wrack observed damaging plant material, evidence of ice scour observed onsite	Replant; install floating boom, wrack fence, or tide gate	Great Ecology	USA/Subcontractor	
Erosion	Signs of erosion (> 10 rills per m^2) /washout observed onsite	Install temporary erosion control measures; re-grade; replant	Great Ecology	USA/Subcontractor	Soil Erosion and Sediment Control Plan

TABLE 2. POTENTIAL PROJECT RISKS

Potential Risks	Action Threshold	Potential Solutions	Solution Initiator	Responsible Party to Act	Specification or Resource
Erosion	Continued signs of erosion, loss of vegetation and soils despite temporary erosion control measures	Consider permanent erosion control mechanisms, (gabions, terracing, etc.); increase planting density	Great Ecology	PMT Team	
Hurricane/ Tropical Storm	Hurricane/Tropical Storm/Nor' Easter/Heavy Wind	Assess vegetation and structural damage; identify areas for potential dewatering; PMT internal team discussion; erosion/wrack evaluation	USA/Great Ecology	PMT Team	
Disease	Observation of diseased vegetation	Identify and contain disease; treat and/or replace damaged material as soon as possible	Great Ecology	USA/Subcontractor	Plant Pathology Guidebook
Planting Medium and Hydric Soil Development	No evidence of soil reduction recorded in monitoring samples	Assess hydrology and consider soil amendments/replacement	Great Ecology	USA	Soil Specification, Surface Water Monitoring Data
Vandalism	Damage from vandalism observed onsite	Contact local law enforcement; assess damage; repair perimeter fencing; clear debris; signage replacement; remove graffiti; replant ASAP	USA	USA	Park Manual/Safety Plan (to be developed)
Fire	Fire occurs onsite: attempt to control with fire extinguisher; call fire department	Assess damage and replant	USA	EPEC	EPEC HASP

3.1.2 Pests/Wildlife

EXAMPLES OF PEST/ WILDLIFE DAMAGE:

- Defoliation/damage to foliage of woody plants;
- Boreholes on woody

Pests (insects) and wildlife (deer, waterfowl, muskrats, etc.) are a common management issue associated with wetland mitigation projects. Great Ecology has implemented preventative measures (deer and goose fencing around wetland plantings) to help prevent large-scale damage. However, if these measures are not sufficient, become damaged, or we identify another pest or wildlife problem onsite, alternative and additional preventative actions will be taken. Evidence of pest/wildlife damage includes, but is not limited to, defoliation or damage to the leaves of woody plants, boreholes on the trunks of wood plants, excessive browsing on grasses and herbaceous species, and uprooting of plants. If we observe wildlife/pest damage, use of pesticides may be considered as a potential solution, as well as additional wildlife deterrents, and replanting with a new native species less attractive to wildlife. Great Ecology and/or an EPEC-selected subcontractor will perform the replanting or pesticide application, if necessary.

3.1.3 Drought

We will monitor the precipitation onsite using local, publically available weather stations. We also will check the soil moisture onsite using tensiometers, hand-held soil moisture meters, or similar devices, to verify the status of plant available moisture. We will monitor groundwater levels using several transducers placed throughout the Site. However, the depth of groundwater is not always a clear indicator of plant available water because of differences in soil texture and the vegetation community type. The soil texture in the wetland mitigation areas is fairly consistent because we will have replaced the top 12 to 18 inches of the soil profile during remediation, but different plant communities will have different moisture requirements and use rates. Additionally, the soils in the uplands will not all be replaced; there will be some native soil left intact. For these reasons, we will verify the plant available moisture in times of drought to determine if irrigation is necessary.

SOIL MOISTURE THRESHOLD

When soil moisture gets to 40 to 60% of field capacity as measured by a handheld soil moisture meter and there is no expected precipitation, we will initiate an irrigation plan for the affected area.

We will take into consideration the severity of the drought, the length of time since planting, and the condition of the vegetation before we initiate extensive irrigation efforts. If necessary due to the likelihood of significant loss of vegetation, we can chose to mitigate drought conditions using temporary watering measures, such as onsite water storage containers, water trucks, and implementation of an irrigation system.

If a particular area experiences drought as a permanent or semi-permanent condition, Great Ecology may consider adapting the plant palette to more appropriately suit the hydrology. However, if wetland mitigation areas do not have adequate hydrology to support hydric vegetation, we will address the underlying issues of elevation and surface water/shallow groundwater flow patterns to ensure we meet permit obligations and overall permit requirements. This scenario would likely require a permit modification to change the habitat type. Great Ecology highly recommends developing an Irrigation and Water Management Plan to proactively address hydrological issues when they arise. Irrigation is not recommended after the first growing season because we want to ensure the plants become established but not dependent on supplemental water from irrigation systems.

We recommend initiating an irrigation plan when plant available moisture gets to 40 to 60% of field capacity as measured by handheld soil moisture meters, and there is no expected precipitation in the foreseeable future. This approach allows ample time to initiate mitigation efforts when there remains sufficient water available for vegetation but before it reaches a permanent wilting point and possible death. The in-place hydrology and water management plan either requires water to be pumped from the open water pond down to the lower wetlands or use of a water truck to effectively irrigate areas that may be water stressed. If there is vegetation loss resulting from extended drought, we will replant in the fall following the growing season before temperatures drop and snow falls.

3.1.4 Flood

Flood conditions are anticipated, as the Site sits low in the watershed and is a natural hydrologic condition of some onsite wetlands. Flooding can occur following large storm events and land use permits require contingency inspections following these types of large events. USA, Great Ecology, and others will perform contingency inspections for damage and hazards following any large storm event. We will monitor hydrology using the permanent transducers placed throughout the Site. If flooding becomes prolonged, dewatering may be required. If flooding becomes an unexpectedly permanent or semi-permanent condition, we will revise the plant palette appropriately. In extreme circumstances, we may need to regrade the flooded areas and raise the elevations to match the actual water levels. Great Ecology recommends developing an Irrigation and Water Management Plan to handle the predicted fluctuations of onsite hydrology.

3.1.5 Open Water Pond Stagnation

The level of oxygen in a pond can be depleted by an excess of certain algae, by increased levels of pollutants, or organic runoff that can chemically react and decrease the levels of available oxygen for certain organisms, such as fish and macroinvertebrates. As oxygen levels decrease it becomes difficult for many organisms to survive. This can lead to the pond becoming eutrophic or even anoxic, which is the state of complete loss of dissolved oxygen (DO).

We do not envision poor water quality during normal conditions. However, we will monitor the water quality of the open water and emergent habitats to detect changes in water quality. In addition, we will monitor algae growth that fosters inherent water quality problems. There are many potential solutions for eutrophic conditions, which if implemented in a timely fashion, will reduce harmful effects before impacting fish and vegetation within the pond.

WATER QUALITY CONCERNS

The PMT should be alerted if dissolved oxygen levels ever drop below **5.0 mg/l** to avert a possible fish kill.

DO levels are inversely related to water temperatures. As water temperatures increase in the summer, DO levels decrease. To restore a eutrophic pond to a more desirable mesotrophic state, dead organic material must decompose at a rate that does not encourage bacteria and algae growth that can rapidly deplete the oxygen level of the water. It is also important that we limit nutrient inputs to the best of our ability. This is most easily accomplished by implementing appropriate buffer areas around the open water habitats. If excess organic material (e.g., algae, duckweed) accumulates in the pond, it will be removed using hand-skimmers. Pond water will be replenished or agitated at regular intervals to prevent the decline of DO. This will happen naturally by design by refilling from stormwater retention basins. However, initial establishment of submerged vegetation may require a more frequently pulsed hydrologic system.

For a larger water quality problem, we may consider bioremediation. Bioremediation, or the application and growth of selected specialized bacteria, is a technique designed to treat and restore eutrophic ponds to a state where fish and vegetation may flourish. If necessary, we will consider the use an aeration system to increase DO levels in the affected area.

Great Ecology will take regular water quality readings of the mitigation pond and emergent habitats during monitoring visits. If a significant drop in DO is observed or if DO levels fall below 5.0 mg/l, and we observe the development of algae and/or stagnant water, we will notify the PMT and recommend solutions to prevent eutrophic conditions and limit any damage that might occur to the aquatic system.

3.1.6 Wrack/Ice Scour

Scouring of the shoreline by wrack and/or ice is a significant concern for the establishment and success of the tidal mitigation area. Wrack and sheets of ice during the winter have the potential to wash onsite during high tides or storm events and scour freshly planted vegetation. We will monitor this condition by visual observation during regularly scheduled Site walks. If such damage is observed onsite, we will recommend replanting during the next appropriate season. If debris and wrack are a continued problem preventing plant establishment, the PMT team may consider recommending the installation of a floating boom, wrack fence, or tide gate to help protect the tidal habitat areas.

3.1.7 Erosion

Excessive erosion has serious effects, such as increased turbidity in receiving water bodies, ecosystem damage, and outright loss of soil creating hazards that are unsuitable for the public or wildlife. We will monitor for signs of erosion during all monitoring events and Site walks. Erosion is a natural process, but if we notice excessive erosion in mitigation areas, we will report this to EPEC and provide supporting data in the form of photographs, GPS coordinates, and documentation. We define excessive erosion as greater than five (5) rills per square meter or the formation of any gullies. Rills are wider than they are deep; whereas, gullies have approximately a 1:1 ratio of width to depth and are larger than rills. We will report any gullies to EPEC immediately for corrective action.

We will determine whether sited erosion is severe enough to require erosion control efforts or just warrants continued monitoring. If mitigation areas onsite display signs of excessive erosion, we will recommend temporary erosion control measures, such as hay bales, straw wattles, and erosion control fencing until we can implement a more permanent solution. Potential permanent solutions include re-grading to create appropriate slopes or erosion control structures (e.g., gabions) as well as supplemental planting to increase vegetation density to reduce rain drop impact and overland flow.

EROSION THRESHOLDS:

- Greater than 5 rills per square meter; and
- Any sign of gully formation.

3.1.8 Hurricane/Tropical Storm/Nor’easters

Hurricanes, tropical storms, and nor’easters have the potential to cause major damage to planted vegetation and structural components of the project, as seen following Hurricane Sandy. In addition, large storms produce a large amount wind and precipitation and can cause temporary flooding conditions and other damage. Great Ecology will perform contingency inspections directly following large storm events and several days following the event to evaluate damage and flood recession. Mitigation areas may need to be dewatered or have weirs cleaned out to allow proper drainage, and damaged vegetation may need to be replanted as quickly as possible to meet permit requirements. Following the onsite inspections, we will develop and recommend plans for the appropriate mitigation strategy.

3.1.9 Disease

USA has purchased all plant material from Pinelands Nursery & Supply and is contractually responsible for replacing any diseased plant material. Thorough plant inspection before acceptance from the contractor should prevent any diseased material from being installed onsite. Post-planting, if any vegetation shows signs of disease, Great Ecology will take the necessary steps to identify the disease and control and eliminate the spread of disease to other plants and other mitigation areas. We will replant affected areas as necessary.

3.1.10 Planting Medium and Hydric Soils

Suitable planting medium (soil) quality is imperative for successful plant establishment in mitigation areas. Inadequate planting medium quality can lead to improper drainage and planting failures. The growth medium being placed in mitigation areas has a large sandy component; accordingly, rapid drainage and low capillary pressure are expected. This could delay the recovery trajectory and increase the time and resources necessary to meet the success standards because redox conditions will take longer to develop, and plants may have a harder time acquiring the moisture they need.

Permit requirements stipulate that soil samples collected in wetland mitigation areas during monitoring activities must display evidence of reduction occurring in the soil. If soils do not display evidence of reduction or other hydric indicators, we will need to re-evaluate the hydrology. If the development of appropriate organic composition off the A-horizon is not appropriate, we would consider a soil amendment to achieve a suitable medium for plant establishment and growth.

3.1.11 Vandalism

We will note and address any damage to mitigation areas (perimeter fencing and signage) during onsite activities and address them as needed. We will immediately contact local law enforcement authorities and mitigate any damage by repairs. A Park Manual/Safety Plan should be developed that specifies security measures and park hours.

3.1.12 Fire

Maintaining the EPEC safety protocol (smoking allowed in designated areas only, mowing >20 feet from utilities, etc.) will likely prevent most fires onsite. However, fires do occur naturally (e.g., during electrical storms), and we will assess the damage and recommend and implement a replanting scheme.

We will encourage contractors and subcontractors to pay careful attention to prevent sparks and/or flames on Red Flag Days when weather conditions are such that there is greater potential for a fast-moving brush fire. Red Flag conditions are defined as wind speeds greater than 25 mph and humidity 15% or less. We will identify Red Flag Day conditions during morning safety meetings before the onset of work activities. All vehicles onsite are required to have a fire extinguisher at all times. It may be appropriate to develop a specific evacuation plan for the Site in the case of a fire that is not containable with a fire extinguisher.

3.2 Decision Process

Following data collection and analysis, we will determine if performance measures or risk endpoints have been triggered. If none of the action criteria are triggered, the adaptive management process can simply continue with the in-place monitoring programs until the next evaluation is performed. If action criteria are triggered (TABLE 2), the PMT will evaluate the circumstances and decide whether to implement prescribed adjustments to the management actions or to undertake additional monitoring or studies to redress the performance standards or risk endpoints that have not been met. This approach permits flexibility in interpreting monitoring results and allows for adjustments to the process and criteria as continuous plan improvements. Following resolution of the PMT recommendations for adjustments to the management actions, the adaptive management process continues by cycling back to the monitoring phase.

4 SUMMARY

Large-scale restoration projects, like the one being undertaken at Woodbridge Waterfront Park, almost inevitably face environmental uncertainty and unexpected circumstances. To appropriately and proactively respond to these risks and uncertainties, we will implement sound AM principles that ensure all project objectives are met and permit requirements are fulfilled. We are tasked with monitoring, evaluating, and assessing the trajectory and success of the project.

There are several functional groups as well as ecosystem processes and services that we have serious concerns about and each has its own recovery trajectories. The mitigation monitoring program we have developed as a part of the AMP and detailed in the MMP will appropriately track and evaluate the systems of interest and allow us to make modifications to management strategies and maintain adherence to the project schedule. We have developed threshold triggers that will help us track if a particular functional group is on the proper trajectory to meet all performance objectives. Some triggers will result in immediate action by the PMT and others simply stimulate discussions on how to proceed. Ultimately, through this AM process, we will provide a highly functioning ecosystem that meets all permit requirements and project objectives through effective planning, modeling, monitoring, and decision-making.

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APPENDIX A:
HABITAT DESCRIPTIONS

The following sections describe the created and existing habitats found at Woodbridge Waterfront Park. Wetland habitats include Emergent Marsh, Emergent Pond, Forested Wetland, Scrub-Shrub Wetland, and High and Low Tidal Salt Marsh, and Brackish Meadow. Upland habitats include Salt Shrubland, Maritime Shrubland, Maritime Forest, and Maritime Meadow. Great Ecology derived all prescribed elevations from datum NAVD 1988.

Emergent Marsh

The majority of the restoration is Emergent Marsh habitat which is composed of perennial persistent and non-persistent herbaceous vegetation. Great Ecology will plant this area with a diverse group of twenty species from genera such as *Carex*, *Juncus*, and *Scirpus*. We integrated into the design salt tolerant species, such as Slender Bur-reed (*Scirpus americanus*), because of the site's proximity to the Raritan and the chance of high spring tide flow into the wetlands. We designed the hydrology of the Emergent Marsh to be saturated or seasonally inundated from 0 to 6 inches.

Emergent Pond

Great Ecology designed Emergent Pond habitat to be located within the Emergent Marsh but in lower elevations, creating deeper water conditions. Emergent Pond vegetation is able to withstand periodic inundation up to 2.5 feet. Great Ecology will plant the Emergent Pond with eight herbaceous species from genera, such as *Juncus*, *Peltandra*, *Sagittaria,* and *Scirpus*.

Forested Wetland

Forested Wetland occurs on the fringe of the Emergent Marsh habitat and also will be scattered throughout mitigation areas, creating a more diverse habitat structure and edge conditions. The Forested Wetland habitat is comprised of a mix of fifteen tree species, four shrub species, and seven herbaceous species from genera such as *Acer*, *Nyssa*, *Salix*, *Clethra*, *Osmunda*, and *Scirpus* to create complex vegetation strata and support diverse species of wildlife. The Forested Wetland areas will be saturated or seasonally inundated from 0 to 6 inches.

Scrub-Shrub Wetland

Great Ecology designed Scrub-Shrub Wetland habitat to occur on the fringe of Emergent Marsh habitat and scattered throughout the mitigation area. This will create vegetation diversity similar to the Forested Wetland habitats. This habitat would support many avian species by providing food and cover with a mix of eleven shrub species and seven herbaceous species from genera, such as *Clethra*, *Cornus*, *Aster*, and *Panicum*. The Scrub-Shrub habitat will be saturated or seasonally inundated from 0 to 6 inches.

Tidal Salt Marsh (High and Low)

Both High and Low Tidal Salt Marsh habitats are influenced by the tidal flow of brackish water from the Raritan River. The High Salt Marsh will be located between Mean High Water (MHW) and Mean High High Water (MHHW), which is 2.25 to 2.59 inches. The Low Salt Marsh will be located between Mean Tide Level (MTL) and Mean High Water (MHW), which is -0.34 inches to 2.25 inches. The Low Salt Marsh is comprised of a modest planting of saltmarsh cordgrass (*Spartina alterniflora*) surrounded by a band of High Salt Marsh plant species, including saltmeadow cordgrass (*Spartina patens*), and saltgrass (*Distichilis spicata*), among others.

Brackish Meadow

Brackish Meadow is moist, moderately well-drained brackish perennial grassland. This habitat will be located above MHHW, but it will be periodically inundated during very high spring tides and storm events (typically 2 to 3 times per year). Great Ecology proposed a combination of four shrubs and six herbaceous species for this area, such as groundsel tree (*Baccharis hamifolia*), marsh elder (*Iva frutescens*), bayberry (*Morella pensylvanica*), and species from other genera such as *Scirpus* and *Hibiscus*, among others.

Salt Shrubland

Salt Shrubland is located just higher in elevation than High Salt Marsh. The vegetation is salt-tolerant because of its proximity to tidal waters, but only will be exposed to tidal flow during extreme events. In addition, the Raritan River has a low salinity level and is not expected to negatively affect the proposed plants in this area. Great Ecology will plant three shrub species and three herbaceous species, including groundsel tree, marsh elder, and switchgrass, among others.

Maritime Shrubland

Maritime Shrubland is tolerant of offshore winds and salt spray typical of a coastal environment. This habitat typically forms patchy mosaics and borders other maritime communities, such as Maritime Forest and Maritime Meadow. It is characterized by shadbush (*Amelanchier canadensis*), bayberry, and beach-plum (*Prunus maritime*).

Maritime Forest

Similar to Maritime Shrubland, Maritime Forest is an upland habitat tolerant to coastal conditions. Great Ecology plans to connect patches of Maritime Forest to existing forests and create new patches for edge and shelter conditions. The species we will plant in Maritime Forest will incorporate existing species found onsite, including gray birch (*Betula populifolia*), sweet gum (*Liquidambar styraciflua*), in addition to others, such as pitch pine (*Pinus rigida*).

Maritime Meadow

Great Ecology will enhance a Maritime Meadow throughout the upland between Maritime Forest and Maritime Shrubland. Great Ecology will seed this open landscape with a mixture of grasses and herbaceous flowering species typical of a coastal environment. Species would include little bluestem (*Andropogon scoparius*), switch grass (*Panicum virgatum*), and golden tickseed (*Coreopsis tinctoria*).

Upland Buffer

Great Ecology will enhance upland areas south of the proposed hydraulic barrier wall to native meadow and forest habitats after spraying and cutting *Phragmites*. Upland habitat is proposed for areas above tidal reach and will be sloped for water drainage. We designed the plantings in the uplands to encourage ecological connectivity between habitats and increase vegetative species richness. In addition, plantings would be particularly thick along the edge of the wetland to discourage reinvasion of invasive species.

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