
Former Residence
Redesign at
Duke Farms

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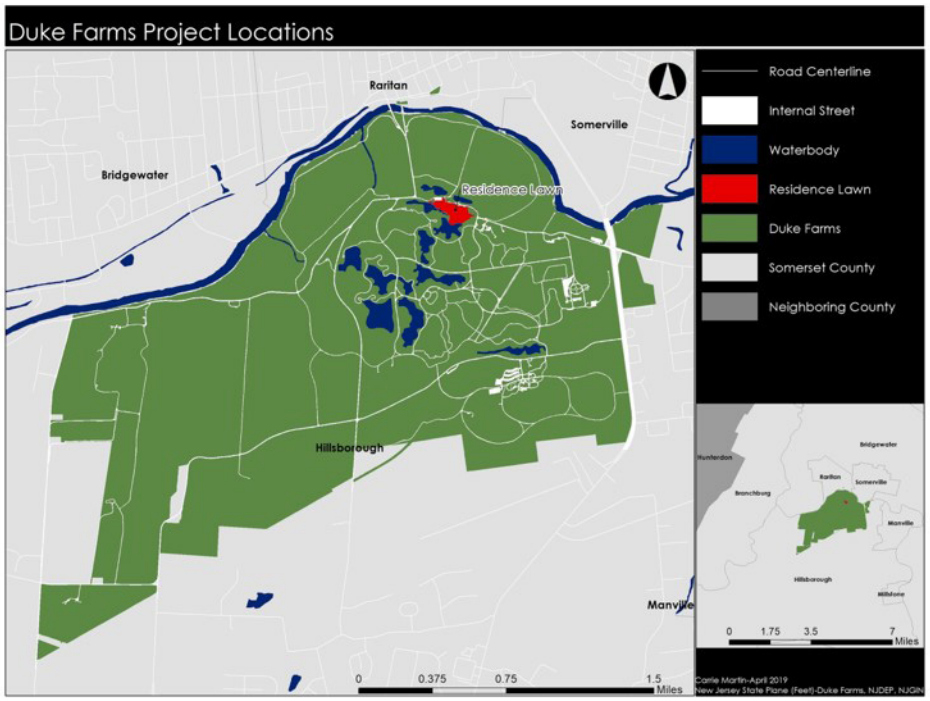
Introduction

The Residence Lawn site, which was once home to the Doris Duke Estate is currently an open plot of land totalling approximately twelve acres. It is located between the Meditation Garden and the Boat House at Duke Farms.

As a team, our goal is to re-create the site into a usuable area that is both attractive to visitors and helps to sequester carbon. In order to do this, we conducted a site analysis to establish the existing conditions, collected inspiration from other precedent sites, and re-searched the science behind carbon sequestration.

After doing this initial background research, we created preliminary designs for the site and established sugggestions for the site to meet our goals. This report includes design options for the site, as well as suggestions for the creation of meadows and an accredited arboretum. We hope these added elements will enhance Duke Farms by adding an attractive site for visitors in addition to furthering their environemntal stewardship goals in regards to carbon sequestration and reduing their carbon footprint.

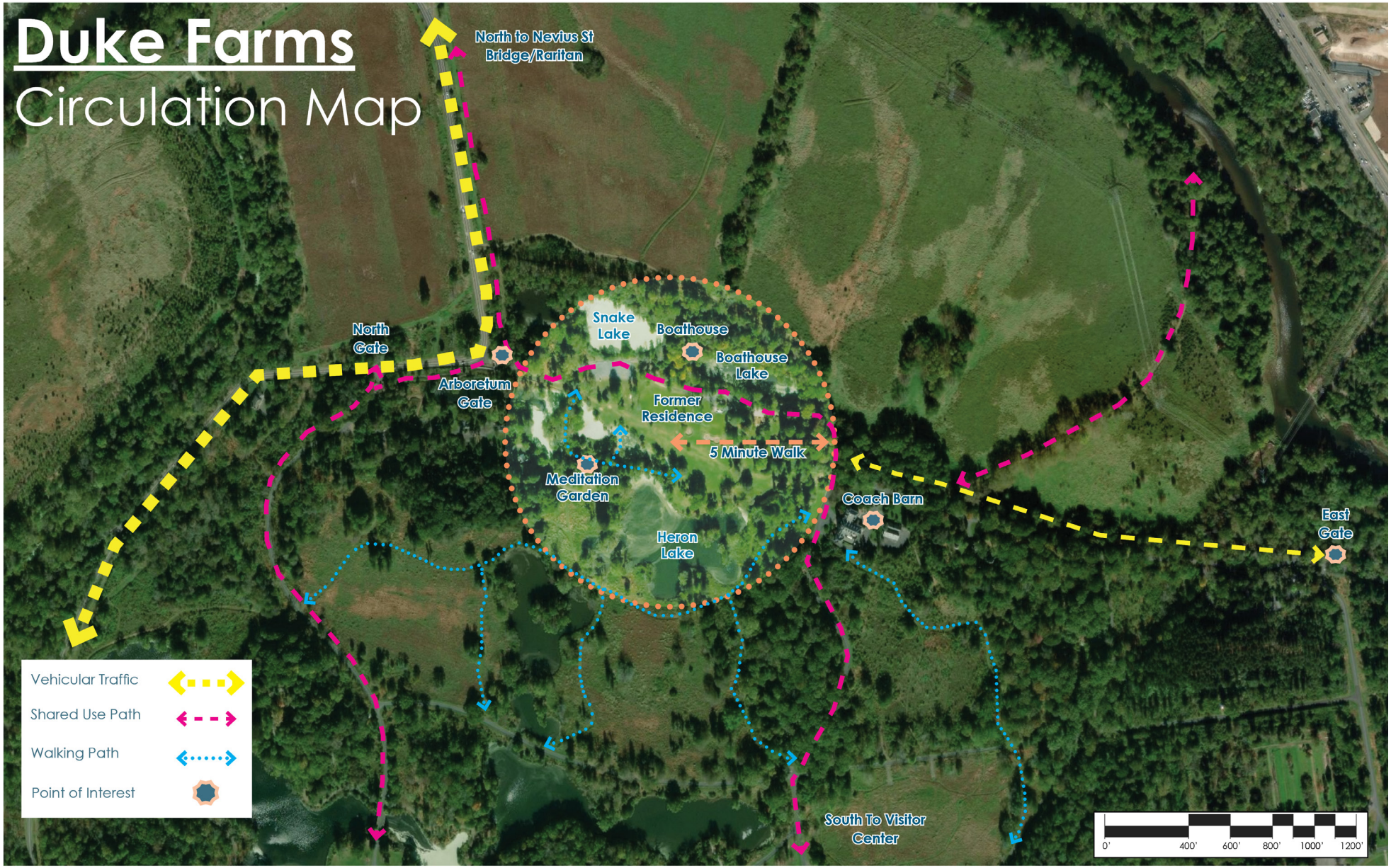


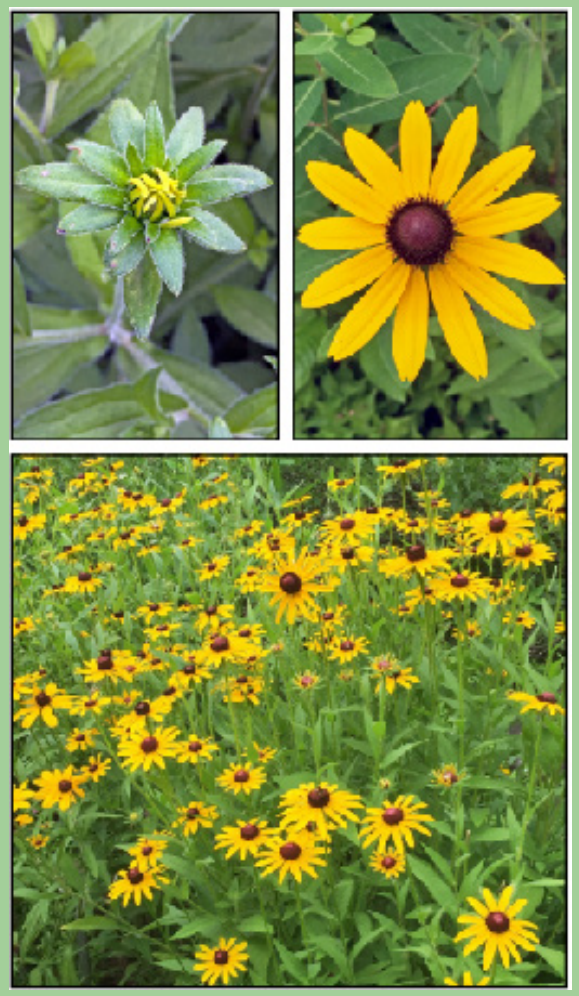
CIRCULATION AND CONNECTION TO SOMERSET COUNTY

Duke Farms currently sits at the edge of the Somerset County Greenway. With the opening of the North Gate, located at the edge of our site, our team sees the opportunity to increase circulation within the site as well as to and from the site from surrounding areas. An improved bike and pedestrian path alongside the Nevius Street Bridge in Raritan is slated to be finished in the Summer of 2019. This will aide in the connection from the Somerset County Parks trails into Duke Farms. Future improvements to the Somerset County Trails connectivity will allow for increased access to Duke Farms, specifically at this site.

In addition to the circulation to the site, we have highlighted potential circulation opportunities within our site to other areas of Duke Farms. Our site is conveniently located within a five minute walking radius of the Meditation garden, The Boathouse and Boathouse Lake, as well as other water bodies such as Heron Lake and Snake Lake.

There are currently many walking and shared use paths that connect the site to other areas of the Duke Farms Property. Additionally, there is vehicular access to the Northern edge of the site.


Duke Farms
Circulation Map
North to Nevius St Bridge/Raritan
North Gate
Arboretum Gate
Snake Lake
Boathouse
Boathouse Lake
Former Residence
5 Minute Walk
Meditation Garden
Heron Lake
Coach Barn
East Gate
South To Visitor Center
Vehicular Traffic
Shared Use Path
Walking Path
Point of Interest
0'
400'
600'
800'
1000'
1200'



Black Eyed Susan

GOALS FOR THE SITE

Overall, our team hopes to take this site which is currently open space and create it into an attractive site at Duke Farms that:

- Sequesters Carbon
- Attracts Pollinators
- Attracts Visitors
- Creates Stunning Viewsheds

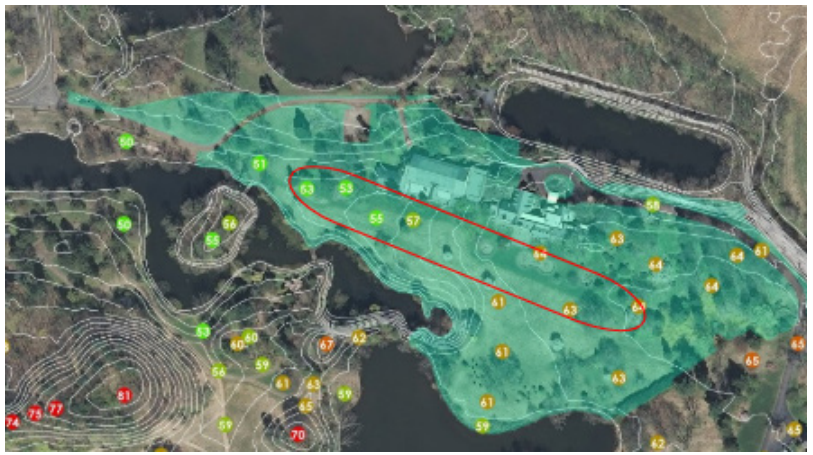
In order to obtain these goals, we have created a design with various options for the site. The two major components of the site include adding a Meadow and enough trees to create an accredited arboretum on the site.

The Meadow

The meadow is being proposed predominantly along the upper dry ridge of the site as delineated by the 2 ft contour map to prevent weed growth on the site[1]. There will be a manicured buffer around the edge of the meadow, as well as a proposed path through the meadow itself. The main path through the meadow is suggested to be at least a 10-ft wide path to allow access for maintenance vehicles through the site. Smaller paths meandering throughout the site are suggested as well to provide more accessibility for visitors throughout the site.

The pollinator meadow will include native plants as well as a variety of grasses and forbs attractive to bees, butterflies, and birds. Using a list of the annual meadow seed mixes for Duke Farms from 2007 to 2011, a plant list for the property in 2012 and the meadow mixes in the 2017 Duke Farms Land Stewardship Plan, we established which plant species were planted on the property for multiple years in a row[2]. Since bees require a habitat and food throughout the seasons, we chose a variety of plants that bloom from Spring to Fall[3].

While a large portion of the meadow includes short grasses and perennial wildflowers (what we call the primary meadow), other sections of the meadow include different types and quantities of plants. The primary meadow includes a variety of short grasses and flowering plants.Suggested grasses for the primary meadow include Broomsedge Bluestem and Gramma grasses[4]. We are also including a nurse crop, or "fast germinating, fast clumping" grass for stability and weed control in year one[5]. The suggested annual nurse crop is Canada Wild Rye. Closer to



the shoreline are grasses that thrive in moist soils and work to stabilize steeper slopes. The intended plantings for this area are Switchgrass, Canada Wild Rye, and Stiff Goldenrod[6]. A drift of tall grasses will be along the edge of the meadow where the trees meet the meadow grasses. These grasses include Big Bluestem, Indian grass, and Purpletop. A drift of only wildflowers (enhanced overlay) will be between the fountains and the pollinator garden to create a stunning viewshed. The plants in the Enhanced Overlay include Milkweed, Beardtongue, Mountain Mint, Butterfly Weed, Wild Bergamot, Black-Eyed Susan, and Fragrant Aster[7]. A complete list of the suggested plant species for the meadow can be found in the appendix.

Implementation Plan

The first stage of establishing the meadow is preparing the site. Although there are a variety of methods for weed control, because the site is currently turf grass, our team specifically recommends sod removal be used for weed control[8].

After site preparation and weed control comes time for seeding. It is important to time the seeding according to the proper planting seasons. The recommended planting season for "Mid-Atlantic Perennial Wildflowers" is October through January. It is recommended to combine seed with material such as sand or sawdust to ease distribution[9].

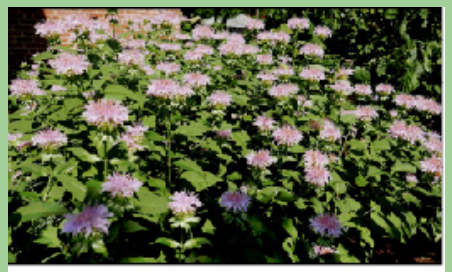
Once the seeds start to grow, proper maintenance is required to maintain the meadow. Throughout the first two years, there will be a greater need for mowing in the meadow to control weed growth while the meadow is in its early stages of establishment. It is suggested to mow the meadow every 6 weeks to a height of 4-6 inches according to Larry Weaner Landscape Associates.

Costs

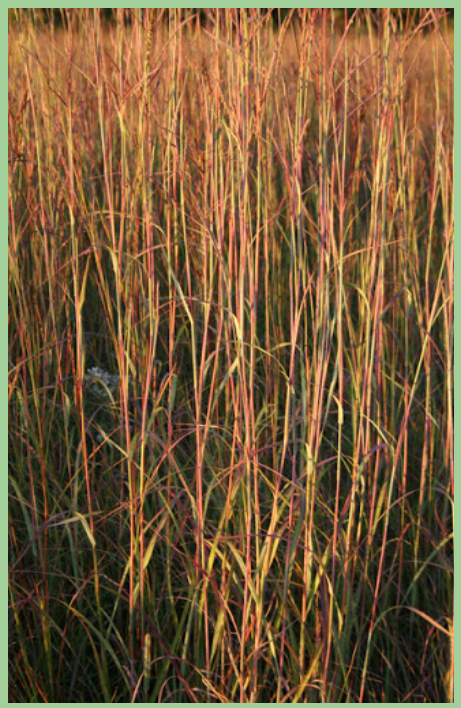
Our team has recommended a total of 18 different species of grasses and wildflowers. Although the Xerces Society has a Seed Mix calculator, since we are not experts in creating seed mixes, we performed a quick back-of-the-envelope cost calculation using an established seed mix as a proxy. The company American Meadows, referenced by the Lady Bird Johnson Wildflower Center, is an online seed retailer. The company sells a mix called the Native Northeast Wildflower Seed Mix. It includes 18 species of exclusively wildflowers, including Butterfly Weed, New England Aster, Wild Lupine, Wild Bergamot, Beardtongue, black-eyed susan, and rigid goldenrod. This seed mix costs $57.95 per pound. According to American Meadows, 50 lbs. Covers 1.5-2 acres[10].

Co-Benefits

A variety of co-benefits abound. The use of native vs. non-native plants, the use of pollinator-friendly plants, and the visually stunning array of flowers are all co-benefits of establishing this meadow. Switchgrass provides food and shelter for birds while Indiangrass provides pollen[11]. Milkweed is critical, because they are the larval host for monarch butterflies. Common Milkweed and Butterfly Weed also attract other insects, including bees[12]. Black-eyed susans bloom throughout the late spring, summer, and the fall, and are known to attract bees[13].



Wild Bergamot



Big Bluestem

The Arboretum

An additional goal of the site is to create an accredited arboretum. The American Public Gardens Association, along with the Interactive Community of Arboreta (Arbnet) have an accreditation process for Arboretums to become officially accredited arboretums. Based on the current and proposed conditions of this site, it is recommended that Duke Farms applies for the Level II accreditation. In order to receive this level II accreditation, the site needs to meet the following criteria:

- An arboretum plan that defines the purpose of the arboretum, its audiences, the types of plants that are to be grown, provisions for the maintenance and care of the plants, and provisions for the continuing operation of the organization through time with a clear succession plan.
- An arboretum organizational group or governing board or authority that is dedicated to the arboretum plan and its continuation beyond the efforts of a single individual.
- An arboretum collection with a minimum of (100) species, varieties or cultivars of trees or woody plants that have been planted and are growing in accordance with the arboretum plan. Plants in the arboretum collection must be labeled in some way as to identify them taxonomically, including scientific name and cultivar if applicable, and documented in some way so that information on their acquisition is available for access.
- Arboretum staff or volunteers who ensure fulfillment of the arboretum plan and provide for the basic needs of the arboretum collection and functions of the arboretum
- An arboretum public dimension that includes some level of public access, and at least one public event or educational program each year focused on trees or arboretum purposes

The first criteria involves creating an Arboretum Master Plan. This Master Plan should address the following - Mission Statement, Objectives, Managment, Documentation of trees and the overall plan for the management of the trees with both long term and short term goals. This proper documentation can help ensure the proper upkeep of the arboretum and provide a stepping stone for future gorwth of the site and aide in the possibility of furthering the accreditation of the site.

While there are an abundance of tree species, and this site will require atleast 100 of them for proper accreditation. Trees such as the London Plane Tree, Sugar Maple, Northern Red Oak, Sycamore, and Black Gum are already present at Duke Farms, and we suggest including these species at this site. Additionally, it is suggested planting native flowering trees that will enhance the surrounding meadows as well. Suggested tree species include Flowering dogwood, Fingertree, Allegheny serviceberry, and Eastern red bud. These provide blooms in the Spring before the meadow will come into full height, allowing for additional pollinator benefits[14].

A table is provided in the appendix with additional species reccomended for the site. One family of trees that is native and plays a role in a meadow and forest environment

American Sycamore

Red Maple

Serviceberry

Pin Oak

Steeplebush

Flowering dogwood

is the Oak family. We suggest a variety of Oak trees such as the Red, White, Scarlet, Willow, Swamp white, and Pin oak. These trees provide many ecological benefits, as they provide a home for insects that are eaten by native birds, adding to the pollinator benefits of the site.

A more comprehensive list of the suggested tree species is available in the appendix.


Primary Meadow
Wet Soil Meadow
Enhanced Drift
Tall Drift Meadow
Manicured Lawn
Clover Field
Shoreline Buffer
Pollinator Garden
Woodland
Water

Design Option 1

This first design is a simpler design that focuses on the primary meadow area as the main component with the trees surrounding the main area. The meadow contains a 10-foot wide path leading from the West end of the site through the pollinator garden, and ends on the East end of the site. There are two additional paths connecting to the two bridges that lead across the water to the meditation garden.

There is a pollinator garden located in the south east portion of the site. This is accessible through the main path leading through the site and has an additional path leading across the water to the editation garden as well.

Additionally, a path is located on the northern portion of the site, leading to the great lawn area and the fountains.

The "Great Lawn" is the northern portion of the site. In this first design, we wanted to strike a balance between a manicured area and a pollinator meadow. The Great Lawn will be a manicured lawn surrounded by native perennial flowers as well as picnic tables for visitors to relax and enjoy the site. In this design, the fountains that are currently inoperaable will be restored to be used again.

In this design, trees are being added mostly to the north west and south east portions of the site. In the area designated for trees near the pollinator garden, it is suggested to plant more flowering trees/shrubs and fruit trees to increase the pollination potential.

Design Option 2

The second alternative for the site builds upon the previous more simple model, creating more pathways to increase circulation among a variety of different elements of the landscape. As seen in the diagram, we have proposed a smaller 6-ft path nearly parallel to the main path that is closer to the water's edge. This allows for a beautiful view across the water to the neighboring meditation garden.

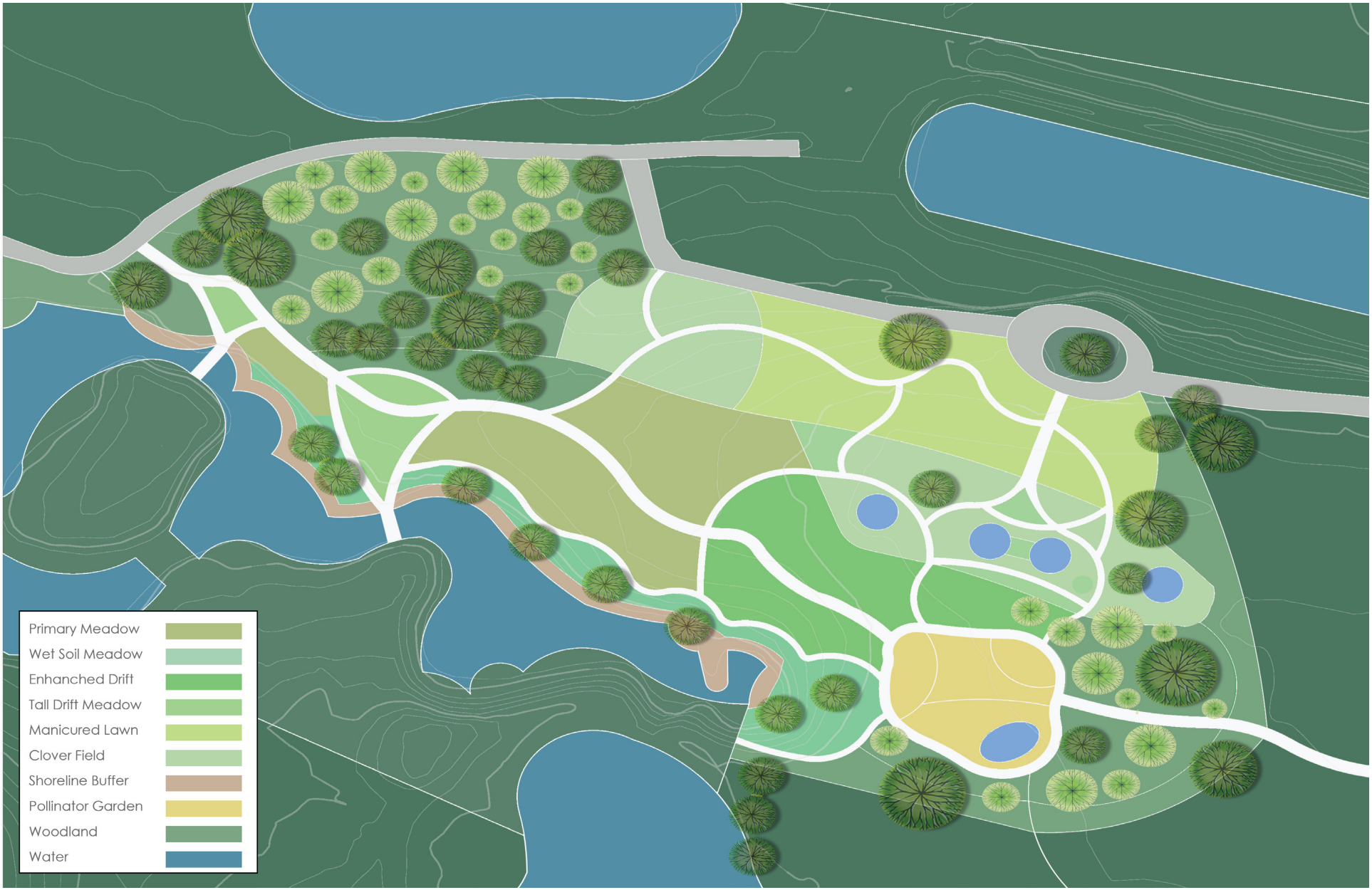
In this design, we have added a greater variety of meadows plants, and hope to have the trees connect and merge more with the meadows, creating one diverse environment for the site.

While a large portion of the meadow includes short grasses and perennial wildflowers, other sections of the meadow include different types and quantities of plants. A drift of only wildflowers (enhanced overlay) will be between the fountains and the pollinator garden to creat a stunning viewshed. These plants include Milkweed, Beardtongue, Mountain Mint, Butterfly Weed, Wild Bergamot, Black-Eyed Susan, and Fragrant Aster.

We hope to maximize carbon sequestration by using clover lawns in addition to turf lawns and a greater diversity of meadow plants.

The fountains will be restored to working conditions in this option as well, and we hope to add more seating and picnic tables in the area of the fountains and on the Great Lawn.

Much like the first design, we intend to have more flowering trees in the portion of the site near the pollinator garden, and suggest for some larger trees such as a variety of Oaks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Water

Increasing Carbon Sequestration Efforts

A major goal for this site is to increase the potential for Carbon Sequestration as well as lower the overall Carbon Footprint of Duke Farms.

Carbon is sequesterd in soil, plants, trees, and their roots. This redesign of the site will be adding many trees as well as 3 acres of meadows in addition to a possible clover lawn suggested in the second design option.

The carbon sequestration potential of the meadow lies in its below-ground biomass. Prairie plants hold about 70-80% of their total mass underground, and have very long substantial root systems. As a result, prarie plants can capture a lot of organic carbon compared to the manicured turf lawn that currently exists on the site.

In addition to the sequestration benefits of the trees and meadows, these added components of the site reduce the amount of mowing and use little to no fertilizers, allowing for Duke Farms to lessen their carbon output. The additon of the clover lawn to the Great Lawn also helps in lowering the demand for mowing, ultimately lowering the carbon output.

Based on a basic calculation using the iTree tool, we found that the addition of 25 trees would sequester 86,381 pounds of carbon in their lifetime. Our site is calling for atleast 100 trees or shrubby plants, greatly increasing the carbon sequestration potential of the site. This calculation was done using a made up mix of five of the following trees - Hickory, American Sycamore, Magnolia, Eastern Redbud, and Pin Oak.

References

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14 National Public Gardens Association - https://www.publicgardens.org/acquiring-arboretum-status
15 Longwood Gardens - https://longwoodgardens.org/meadow-plants
16 Arbnet - Requirements for Arboretum Master Plan - http://arbnet.org/sites/arbnet/files/ArbNet%20Sample%20Arboretum%20Plan.pdf
17 New Jersey Agricultural Experiment Station Fact Sheet - https://njaes.rutgers.edu/fs1280/

Appendix A - Meadow Mix

Table 1. Suggested Plant Species			
Botanical Name	**Common Name**	**Bloom Time**	**Soil Types**
Tall Grasses			
Andropogon gerardii	Big Bluestem		
Sorghastrum nutans	Indian grass		Dry, Mesic
Tridens flavus	Purpletop		
Short Grasses			
Andropogon virginicus	Broomsedge Bluestem		
Bouteloua curtipendula	Sideoats Gramma		
Bouteloua gracilis	Blue Gramma Grass		
Nurse Crop			
Elymus canadensis	Canada Wild Rye		Dry, Mesic, Wet

Table 1. Suggested Plant Species			
Botanical Name	**Common Name**	**Bloom Time**	**Soil Types**
Forbs			
Asclepias syriaca L.	Common Milkweed	Late Spring/Summer	
Penstemon digitalis	White/ Foxglove Beardtongue	Late Spring/Summer , Early	Dry, Mesic
Asclepias tuberosa	Butterfly Weed	Late Spring/Summer, Mid	Dry, Mesic
Monarda fistulosa	Wild Bergamot	Late Spring/Summer, Mid	Dry, Mesic
Rudbeckia hirta	Black-Eyed Susan	Late Spring/Summer/Fall	Dry, Mesic
Symphyotrichum oblongifolium (Nutt.) G.L. Nesom	Fragrant Aster	Late Summer/Fall	
Pycnanthemum tenuifolium Schrad.	Narrow-leaf Mountain-Mint	Late Summer/Fall, Mid	
Symphotrichum novae-angliae	New England Aster	Late	
Lupinus perennis	Perennial Lupine		
For Wetter Soils/On Slopes for Stabilization			
Panicum virgatum	Switchgrass		Mesic, Wet
Elymus canadensis	Canada Wild Rye		Dry, Mesic, Wet
Solidago rigida	Stiff Goldenrod	Late Summer/Fall	Dry, Mesic, Wet

Appendix B
Suggested Trees

Common Name	Species Name
Flowering dogwood	Cornus florida
fringetree	Chionanthus virginicus
Allegheny serviceberry	Amelanchier laevis
Eastern redbud	Cercis canadensis
White oak	Quercus alba
Red oak	Quercus ruba
Scarlet oak	Quercus coccinea
Willow oak	Q. phellos
Swamp white oak	Q. bicolor
Pin oak	Q. palustris
Japanese maple	Acer palmatum
Common Juniper	Juniperus communis
Silver maple	Acer saccharinum
Red maple	Acer rubrum
Trident maple	Acer buergerianum
Crepe myrtle	Lagerstroemia
Magnolia	Magnolia virginiana
Willow	Salix Discolor
Wild Azalea	Rhododendron
Black Tupelo	Nyssa sylvatica
Rose	Rosa
Steeplebush	Spiraea tomentosa
Basswood	Tila americana
False Indigo Bush	Amorpha fruticosa