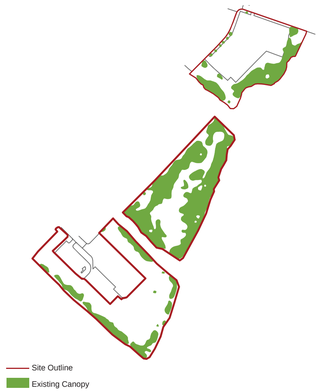
theURBANGROVE

in association with the BES and Middle Branch Masterplan

The Pennsylvania State University - Danielle Sette - LArch 414 - 4.21.14

EXISTING conditions → PROPOSED conditions



Site 1 — 4.42 acres

CANOPY 26%
IMPERVIOUSNESS 51%
LAWN + OTHER 23%

Site 2 — 5.28 acres

CANOPY 62%
IMPERVIOUSNESS 04%
LAWN + OTHER 34%

Site 3 — 5.39 acres

CANOPY 19%
IMPERVIOUSNESS 05%
LAWN + OTHER 76%

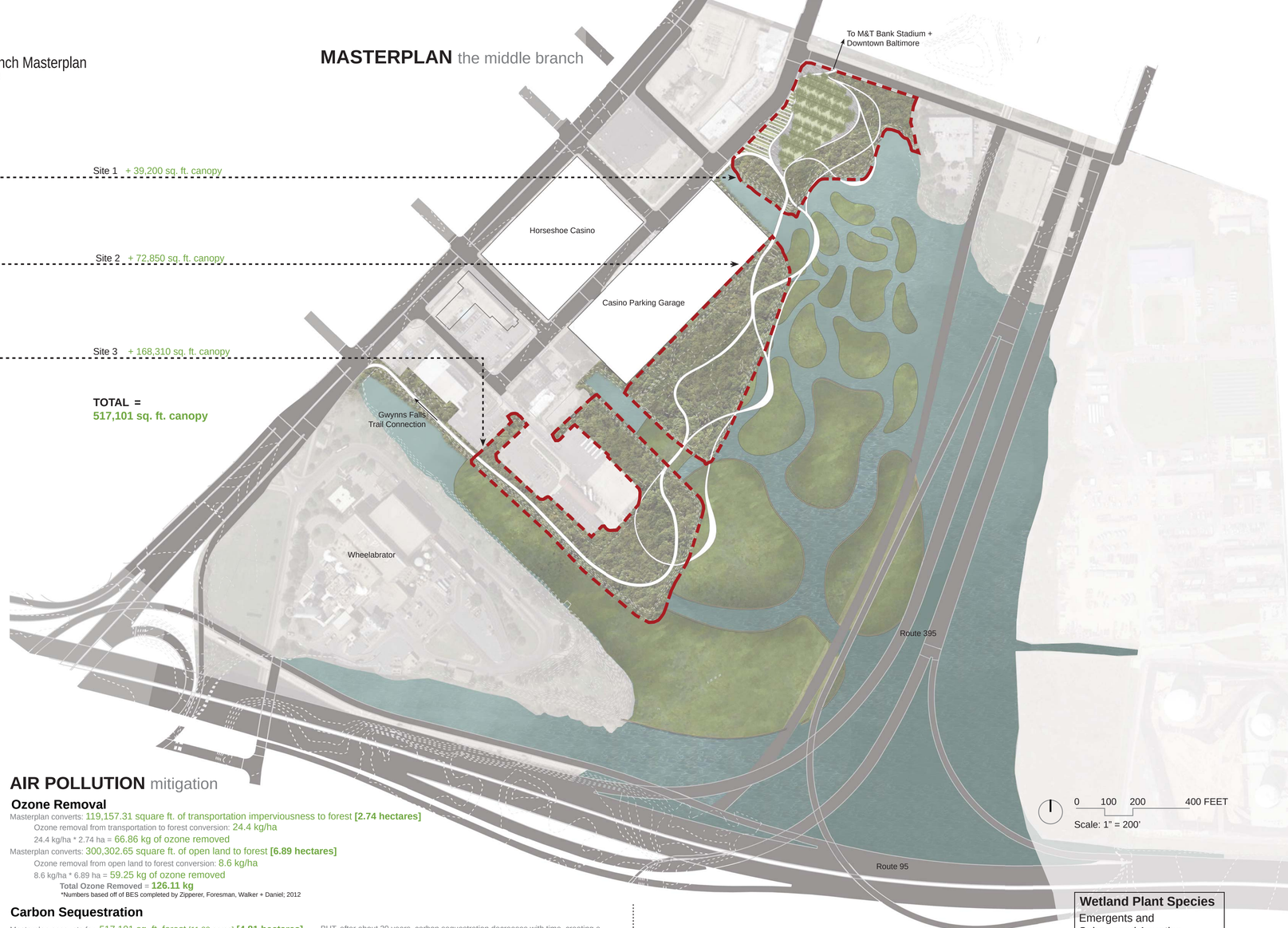
46% CANOPY ← Site 1 + 39,200 sq. ft. canopy
09% PERVIOUS PATHWAY
45% LAWN + OTHER

94% CANOPY ← Site 2 + 72,850 sq. ft. canopy
06% PERVIOUS PATHWAY

91% CANOPY ← Site 3 + 168,310 sq. ft. canopy
09% PERVIOUS PATHWAY

TOTAL =
517,101 sq. ft. canopy

MASTERPLAN the middle branch



CONCEPT the grove

The concept of an urban grove seeks to combine human activity, ecological vitality, and strategic planning for future resources to enhance urban ecology within the Middle Branch. The revitalization of the forested edge provides habitat for urban shoreline nesting species, passive recreation opportunities, and potential for mitigating ozone and other criteria pollutants which occupy Baltimore's atmosphere. Overall, the grove intends to bring about awareness to air pollution issues within Baltimore and the Middle Branch, as well as promote ecological growth.

BALTIMORE air pollution importance

Geographic Location

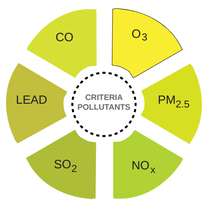
The convergence of inland winds with backwinds from the ocean trap pollutants within Baltimore, increasing overall pollutant concentrations from regional non-point source pollutants.

Point Sources

In addition to its geographic location, Baltimore is also home to a rich industrial past and present which contribute to local air pollution production. Some of the sources in the immediate region of the masterplan sites are noted in the map to the left.

- Chemical Metals Industry
- Lyon Conklin & Co [HVAC Equipment Company]
- Wheelabrator [Waste to Energy Company]
- Masterplan Sites

FORMATION ozone

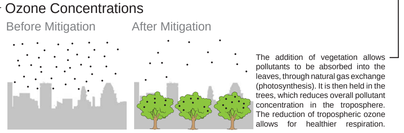


The 6 criteria air pollutants were selected under NAAQs [National Ambient Air Quality Standards]. These pollutants are monitored by the EPA due to their anthropogenic sources and human, as well as environmental, health effects. Ozone is a main concern due to the serious health effects it may cause, especially in young children and the older population.

Ozone Formation

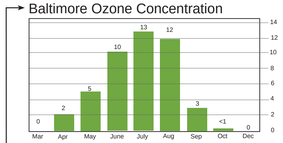
Since ozone is a secondary pollutant, it is formed from sunlight, nitrogen oxides and VOCs under the right weather conditions. Because of the requirement for sunlight, ozone concentrations tend to be higher during the day, and during seasons with warmer temperatures. Baltimore's ozone seasons ranges from May - October, when ozone levels are at their peak, and air quality is the worst.

Ozone Concentrations



The addition of vegetation allows pollutants to be absorbed into the leaves, through natural gas exchange (photosynthesis). It is then held in the trees, which reduces overall pollutant concentration in the troposphere. The reduction of tropospheric ozone allows for healthier respiration.

Baltimore Ozone Concentration



The graph above portrays the number of days in Baltimore in 2008 which were considered unhealthy to sensitive groups (the young and the old) based on the AQI (Air Quality Index).

Ozone can make environmental exposure unhealthy because it is an oxidizing agent. When breathed in, it makes contact with soft, moist tissue (the lungs) and causes damage to them. Therefore, making people with asthma or cardiovascular issues at the most risk.

Source: http://mde.maryland.gov/programs/Air/AirQualityMonitoring/Documents/AQFacts/OzoneSeasonalClimo.pdf

Baltimore Pollution Health Affects

According to MarylandReported.com, **130 out of every 100,000 people** located in Baltimore, are likely to die premature deaths every year due to air pollution. This rate is higher than New York City, Los Angeles, and the entire Washington, D.C. Metropolitan area.

Source: http://marylandreporter.com/2013/09/13/maryland-emissions-related-deaths-highest-in-u-s/

AIR POLLUTION mitigation

Ozone Removal

Masterplan converts: 119,157.31 square ft. of transportation imperviousness to forest **[2.74 hectares]**
Ozone removal from transportation to forest conversion: 24.4 kg/ha
24.4 kg/ha * 2.74 ha = 66.86 kg of ozone removed
Masterplan converts: 300,302.65 square ft. of open land to forest **[6.89 hectares]**
Ozone removal from open land to forest conversion: 8.6 kg/ha
8.6 kg/ha * 6.89 ha = 59.25 kg of ozone removed
Total Ozone Removed = 126.11 kg
*Numbers based off of BES completed by Zipperer, Foresman, Walker + Daniel; 2012

Carbon Sequestration

Masterplan accounts for: 517,101 sq. ft. forest [11.88 acres] **[4.81 hectares]**
Mean carbon sequestration/year: 1,497.8 kg/ha forest
1,497.8 kg/ha * 4.81 ha = 7,204.42 kg/year **[7.20 metric tons/year]**
*Numbers based off of BES completed by Zipperer, Foresman, Walker + Daniel; 2012
Average Driver: 10,000 miles/year = 10,500 lbs carbon/year
Masterplan sequesters = 7.2 metric tons/year **[15,873.3 lbs/year]**
OR the equivalent of removing **1.6 cars off the road each year**

*Numbers based off climatecentral.org

BUT, after about 20 years, carbon sequestration decreases with time, creating a maximum sequestration limit
Maximum carbon storage = 79,701.5 kg/ha
Masterplan accounts for for = 4.81 hectares
Maximum carbon sequestration = 383,364.22 kg **[383.36 metric tons]**
OR the equivalent of removing **80.5 cars off of the road**

Nitrogen Dioxide Removal

Masterplan converts: 2.74 hectares of transportation to forest
NO2 removal from transportation to forest conversion: 15.7 kg/ha
15.7 kg/ha * 2.74 ha = 43.02 kg of NO2 removed
Masterplan converts: 6.89 hectares of open land to forest
NO2 removal from open land to forest conversion: 5.5 kg/ha
5.5 kg/ha * 6.89 ha = 37.9 kg of ozone absorbed
Total NO2 Removed = 80.92 kg
*Numbers based off of BES completed by Zipperer, Foresman, Walker + Daniel; 2012

PM10 Removal

Masterplan converts: 2.74 hectares of transportation to forest
PM10 removal from transportation to forest conversion: 20.2 kg/ha
20.2 kg/ha * 2.74 ha = 55.35 kg of PM10 removed
Masterplan converts: 6.89 hectares of open land to forest
PM10 removal from open land to forest conversion: 7.1 kg/ha
7.1 kg/ha * 6.89 ha = 48.92 kg of ozone absorbed
Total PM10 Removed = 104.27 kg
*Numbers based off of BES completed by Zipperer, Foresman, Walker + Daniel; 2012

WETLAND nitrogen removal

The creation of wetland habitat will aid in absorbing nitrogen runoff from the newly created urban forest 'riparian' zones

An Addition of: 24 acres of wetland [319,550 sq. meters]

Average Dry Weight of Native Maryland Species after 2 years: 0.35kg/sq. meter

Total Added Biomass: 111,842.70 kg

Total current Max Nitrogen load in Baltimore per year: 3,547,309 kgN/y

Baltimore's yearly load goal: 2,419,983 kgN/y
[a decrease of 1,127,326 kgN decrease or 32%]

Average max nitrogen removal by wetland plants: 0.37kgN/sq meters/year

This site: 0.37kgN/y X 319,550.50sq.m=
118,233.70 kgN/y
Or approximately:

10% of the goal set by Baltimore

Source: http://www.stormwatercenter.net/Library/Practice/89.pdf for net weight of wetland biomass

Wetland Plant Species

Emergents and Submerged Aquatics

Andropogon glomeratus
Bushy Beard Grass

Peltandra virginica
Arrow Arum

Sagittaria latifolia
Duck Potato

Nuphar luteum
Spatterdock

Alisma plantago-aquatica
Broad-leaf Water-plantain

Caltha palustris
Common Marsh Marigold

FOREST IMPLEMENTATION habitat creation

Tree Species for pollution mitigation

Platanus acerifolia
London Plane

Juglans nigra
Black Walnut

Taxodium distichum
Bald Cypress

Aesculus hippocastanum
Common Horse Chestnut

Quercus rubra
Red Oak

Quercus coccinea
Scarlet Oak

Pinus ponderosa
Ponderosa Pine

Pinus resinosa
Red Pine

Quercus virginiana
Virginia Live Oak

Bird Habitat Urban Shoreline Species [As noted by the BES Bird Monitoring Project; Birds in Everyday Baltimore]

Falco sparverius
American Kestrel

Molothrus ater
Brown-headed Cowbird

Phalacrocorax auritus
Double Crested Cormorant

Larus marinus
Great Black-backed Gull

Agelaius phoeniceus
Red Winged Blackbird

Tachycineta bicolor
Tree Swallow

Larus delawarensis
Ring-billed Gull

Ardea herodias
Great Blue Heron

Hirundo rustica
Barn Swallow

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DESIGN the grove

The grove is designed to be a demonstrative and changing landscape. As the herbaceous species and trees grow, scientists will be able to monitor the landscape and any foliage changes due to concentrations of ozone or other air pollutants greater than ambient level. High concentrations of these pollutants will cause injury to the foliage.

Winding pathways and raised deck spaces, as well as scattered sitting walls throughout the grove, encourage the interaction of visitors within the site.

Landscape Phasing + Changes

Ozone Monitoring - Bioindicators

1-5 years

Herbaceous bioindicators will need to be removed and replanted every 1-5 years depending on the species. Because herbaceous species grow quickly, it is important to continually change them in order to have up-to-date foliage injury for documentation.

10-15 years

Trees used in the grove as bioindicators will need to be replanted approximately every 10-15 years if severe ozone injury occurs. If leaves are pre-senescing (turning yellow) or growth is stunted, trees shall be removed in order to keep aesthetic quality to the space. If serious injury does not occur, trees may be kept in the grove for further monitoring.

Pollutant Mitigation

15-30+ years

Mitigation of pollution from the forest species will change over a period of time. While the trees are young and still growing, they will have the capability to absorb more pollutants, (as noted in the carbon calculations before). After about 20-30 years, the trees will have a smaller capacity for pollution storage. Therefore, to keep pollution mitigation going, the forest may need to be thinned out and have new saplings planted. A continuous cycle of cutting and replanting trees will allow for higher pollution removal from the atmosphere.

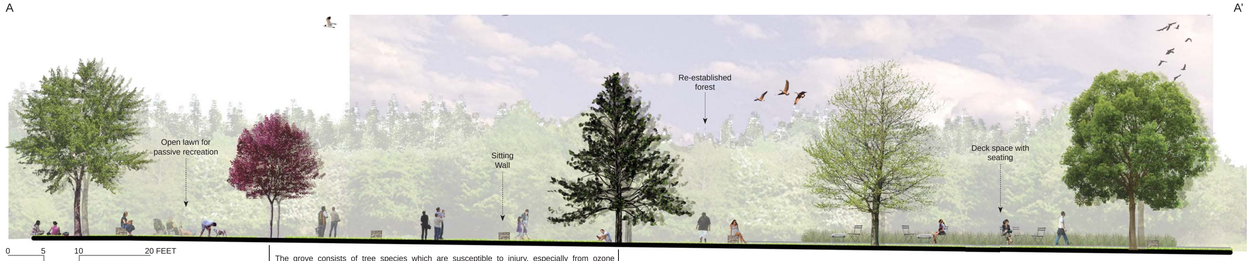
Year 1 - Planting

Year 15-20

Year 25-35

30+ year old · 20-30 year old · 10-20 year old · 0-10 year old

A — A'



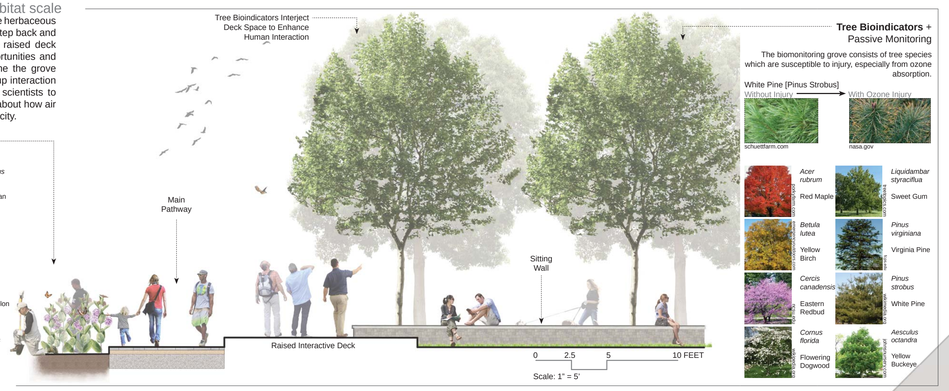
The grove consists of tree species which are susceptible to injury, especially from ozone absorption. The trees are spaced so that competition is minimized, and canopies are allowed to flourish. By mitigating these conditions, it is easier to monitor injury, growth stunt, or lack of foliage based on ozone absorption (rather than other natural injury sources).

Interaction at the human-habitat scale

A slighlty raised deck located between the herbaceous and tree bioindicators allows visitors to step back and appreciate the monitoring system. The raised deck acts as a platform for educational opportunities and passive recreation. Sitting walls that line the grove trees interject the deck areas for close-up interaction with the plants. This interaction allows scientists to monitor the plants, and visitors to learn about how air pollution affects plant species within the city.

Herbaceous Shrub Bioindicators + Passive Monitoring

Rudbeckia hirta	Black-Eyed Susan	*Phaseolus vulgaris*	Pinto Bean
Rudbeckia laciniata	Cut-leaf Coneflower	*Symphyotrichum puniceum*	Purple Stemmed Aster
Vernonia noveboracensis	NY Ironweed	*Citrullus lanatus*	Watermelon
Asclepias exaltata	Tall Milkweed	*Lobelia cardinalis*	Cardinal Flower



Tree Bioindicators + Passive Monitoring

The biomonitoring grove consists of tree species which are susceptible to injury, especially from ozone absorption.

White Pine [Pinus Strobus]

Without Injury → With Ozone Injury

schuestfarm.com · nasa.gov

Acer rubrum	Red Maple	*Liquidambar styraciflua*	Sweet Gum
Betula lutea	Yellow Birch	*Pinus virginiana*	Virginia Pine
Cercis canadensis	Eastern Redbud	*Pinus strobus*	White Pine
Cornus florida	Flowering Dogwood	*Aesculus octandra*	Yellow Buckeye

Main Walkway

The main pedestrian path acts as a link between M&T Bank Stadium and the upcoming casino to the south. When walking down the path, pedestrians will intercept the herbaceous and tree bioindicator spaces. Smaller pathways and seating areas encourage visitors to immerse themselves into the space and learn about the air pollution monitoring and mitigation taking place on site.

Forest Restoration

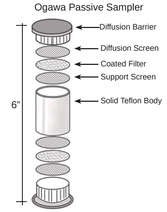
The forest restoration area around the edge of the site will aid in mitigating air pollution as well as provide immersion experiences for visitors. The forested edge provides a strong sense of enclosure, while the paths lead visitors out towards the water for panoramic views of the bay. Within the forest space, visitors will have close interaction with urban edge bird species.

SITE DESIGN the middle branch

Welcome Plaza + Passive Monitoring

In addition to bioindicator plant species for monitoring, passive samplers will be installed within the welcome plaza to collect samples of atmospheric gases and particles. Within the sampler, atmospheric ozone oxidizes the nitrite filters into nitrate, which exposes the presence of any ozone. These passive samples are good for averaging atmospheric pollutants over a certain period of time. Filters will be replaced and sent to a lab every week for testing during year 1.

Ogawa Passive Sampler



Sample Collection	
Year 1	Samples collected weekly and sent to lab for testing
Year 2	Samples collected bi-weekly and sent to lab for testing
Year 3 and on	If poor air quality persists, an active sampler will be implemented on site to monitor real time data

Connection to M&T Bank Stadium + Downtown Baltimore

Interactive Deck + Seating

Tree Bioindicators + Passive Monitoring

Sitting Wall

Herbaceous Bioindicators + Passive Monitoring

Open Lawn

Sitting Wall

Bioindicator Tree Rows

B

A'

Interactive Deck + Seating

A

B'

Raised Forest Walkway

A ramped forest walkway encourages visitor interaction with the canopy and allows for close monitoring of the foliage

Connection to Casino + Parking Garage

Views out to wetland habitat

Connection to Gwynns Falls Trail + Masterplan Sites

0 15 30 60 FEET

Scale: 1" = 30'

Resources Used:

Air Pollution Studies

Maryland Department of the Environment, 2008. Air Quality Facts. Ozone – Seasonal Climatology. http://mde.maryland.gov/programs/Air/AirQualityMonitoring/Documents/AQFacts/OzoneSeasonalClimo.pdf

Maryland Reporter. 2013. Maryland Deaths from Air Pollution Highest in U.S. http://marylandreporter.com/2013/09/13/maryland-emissions-related-deaths-highest-in-u-s/

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GIS Data

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Habitat Studies and Animal Species

Baltimore Ecosystem Study. BES Bird Monitoring Project; Birds in Everyday Baltimore. http://www.beslter.org/frame4-page_3h_04.html

Chesapeake Bay Program Bay Field Guide. http://www.chesapeakebay.net/fieldguide

Nilon, C. H., P.S. Warren, and J. Wolf. 2009. Baltimore Birdscape Study: Identifying habitat and land-Cover variables for an urban bird-monitoring project. Urban Habitats 6. http://www.urbanhabitats.org/v06n01/baltimore_full.html

Masterplan Plant Palette and Animal Species

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Chesapeake Bay Program Bay Field Guide. http://www.chesapeakebay.net/fieldguide

City of Baltimore Department of Recreation and Parks. Baltimore City Street Tree Species List. 2013. http://bcrp.baltimorecity.gov/Portals/Parks/documents/StreetTreeSpeicesList_BaltimoreCity_Final_7-08-2013.pdf

Maryland Department of the Environment - Wetland Plants. http://www.mde.state.md.us/assets/document/wetlandswaterways/wetplant.pdf

Maryland Department of the Environment - Landscape Guidance for Stormwater BMPs. http://www.mde.state.md.us/assets/document/sedimentstormwater/Appnd_A.pdf

Net weight of Wetland Biomass

Maryland Department of the Environment. http://www.mde.state.md.us/programs/Water/TMDL/ApprovedFinalTMDLs/Documents/BaltimoreHarbBa_NUT_DR.pdf

Total yearly load of nitrogen

Nutrient Dynamics and Plant Diversity in Volunteer and Planted Stormwater Wetlands. http://www.stormwatercenter.net/Library/Practice/89.pdf

Tree Canopy Information

City of Baltimore Department of Recreation and Parks. What is the Tree Canopy. http://bcrp.baltimorecity.gov/SpecialPrograms/TreeBaltimore/WhatistheTreeCanopy.aspx

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