resource: Rain

Low Impact Development Design Challenge

TEAM 17463

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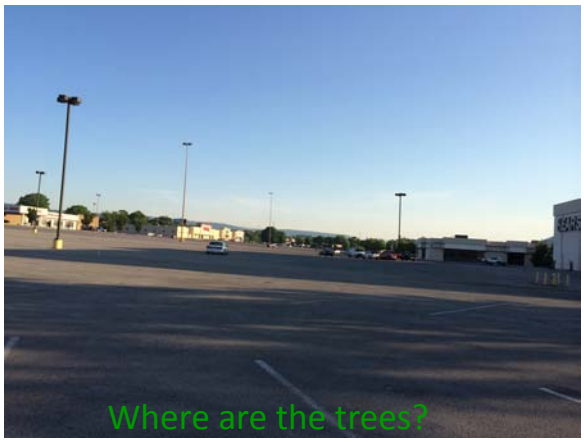
Design Concepts



The design concept for the Northgate Mall site is to take a 79 acre urban desert and transform it into connected, walkable, corridors of green space that incorporate low impact development best management practices to capture and reuse rainwater. The site was divided into 28 smaller sub-drainage areas based on the existing site conditions and then bmp's were chosen for these areas.

The goal was to capture the first inch of rainfall and this was accomplished through the use of bioretention, underground detention, rainwater cisterns, a roof garden, tree planting, the living machine, and permeable pavement.

Bioretention

These open spaces are defined by a series of continuous bioretention cells that separate the parking lot from the mall. These bioretention cells provide a peaceful space for pedestrian activities. Pedestrian bridges connecting the parking lot to the mall entrances allow people to get closer to the bioretention cells and actually experience the planting area within the stormwater facility. The goal is for the public to become more aware of the benefits the systems can offer and encourage more participation and funding sources for future projects.

Permeable Pavers/Pedestrian Connectivity

The existing mall space does not have pedestrian connections to the outparcels. Several pedestrian walkways are proposed to be added to the site to provide connections between the mall, movie theater, restaurants, and proposed park areas to provide safe passage and encourage use of all the facilities.

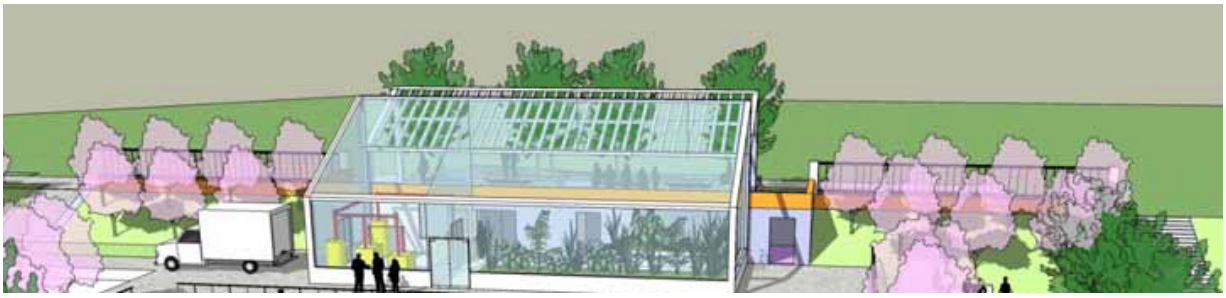
The permeable pavers also provide capture volume and pollutant removal.

Rain Cisterns

The new open spaces will feature details that relate with the character of Chattanooga and encourage patrons to linger. The natural beauty of the area should be showcased with native plants and natural material including fieldstone, flagstone, slate and boulders. The food court structures should be crafted from native natural hardwoods to reflect the materials and talent of the region. The rainwater cisterns can provide a venue for the local businesses to sponsor the redevelopment and showcase their products. These spaces will also create an ideal location for climbing walls which will enhance the outdoor feel of the area.

Living Machine

Using harvested stormwater from rain cisterns is not a new concept. Today's technology allows us to explore new ways to use stormwater and wastewater for everyday use. Our design seeks to introduce this technology within the project area and explore ways to treat, recycle and conserve wastewater through an ecological process that mimics the functions of wetlands. The goal is not only to treat wastewater on site and replace conventional wastewater treatments, but to educate the public about the current environmental and economic issues impacting water resources and the ecologically minded solutions available. A facility similar to a "Living Machine" would treat much of the roof's captured rainwater in the cisterns. The system is composed of a series of "pools" that host specific organisms. Each "pool" has a designed community of aquatic and wetland organisms such as; plants, bacteria, algae, protozoa, plankton, snails and other organisms that are used to provide specific cleansing or trophic functions. Because the project is located in a mall and the geographic location of the site, the system will be housed in a greenhouse with tanks, pipes, and filters. Introducing this type of technology to the general public will benefit the mission of conservation and preservation, and invite innovative solutions for common causes.



Green Roof

One such cause is food production in urban areas. Part of the greenhouse could be used for non-living machine purposes and could include agricultural uses. The greenhouse would become the starting place for a broader food production operation within the project limits. Some of the vast roof area could be turned into a green roof that would provide space for vegetables, herbs, and fruits. The water needed for irrigation would be provided by the ecological treatment facility, and the crops could be sold in a Farmer's Market within the mall boundaries. Eventually, the crops could be sold to nearby restaurants that embrace the concept of local sustainable organic products.

Parks / Green Space

The Hixson—North River Community Plan desired the addition of green space and pedestrian walkways to the Northgate Mall property. Our plan proposes the addition of two unique park spaces. Both park spaces will be constructed over a stormwater detention tank. The water will be captured and reused for irrigation purposes.

North East Park

The concept for the park in northeast corner of the property took into consideration the proximity of the neighboring library and North River Community Center. The park will include a natural playground with grass, trees, boulders for seating, climbing, and play. A shaded area /pavilion will provide space to stage story time with the library, showcase local music talent from the community center, or could be rented for a child's birthday party. The park will feature a playground with a nature theme and provide signage for environmental education directed towards a younger audience.

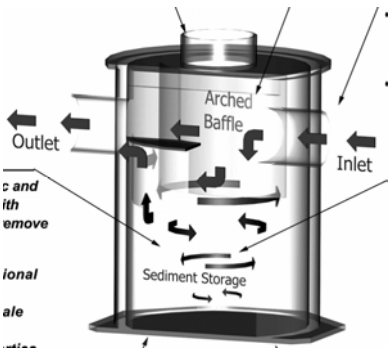
Parks / Green Space

South West Park

The south west corner of the property is known to flood during high intensity storm events. The area chosen is also located behind the Toys R Us store in the adjacent outparcel. Children are naturally drawn to water and a splash park was easy to envision in this corner. As in the case with the northeast park, stormwater will be held underground in detention and reused to provide irrigation for the park.

Pollutant Removal and Total Suspended Solids (TSS)

Bioretention and permeable pavers have the ability to remove 80% of TSS. All of the retention areas will remain connected to the storm sewer system to handle high intensity rainfall events. To assist with TSS and pollutant removal, Aqua-swirl units will be installed at each of the three outfall pipes to provide a final treatment of stormwater before discharging into a tributary to North Chickamauga Creek.



Wildlife Habitat

The bioretention cells will include planting designed to support the migration of the Monarch Butterfly. We will develop a design that will ultimately become a Certified Monarch Butterfly Waystation and be part of the North American effort to restore the population of the monarch butterfly - http://www.monarchwatch.org/waystations/ .

A waystation integrated into the design of the parking lot's bioretentiion cell would receive the label of "Colossal" and provide a significant benefit for the monarchs and the other species that share this ecosystem.

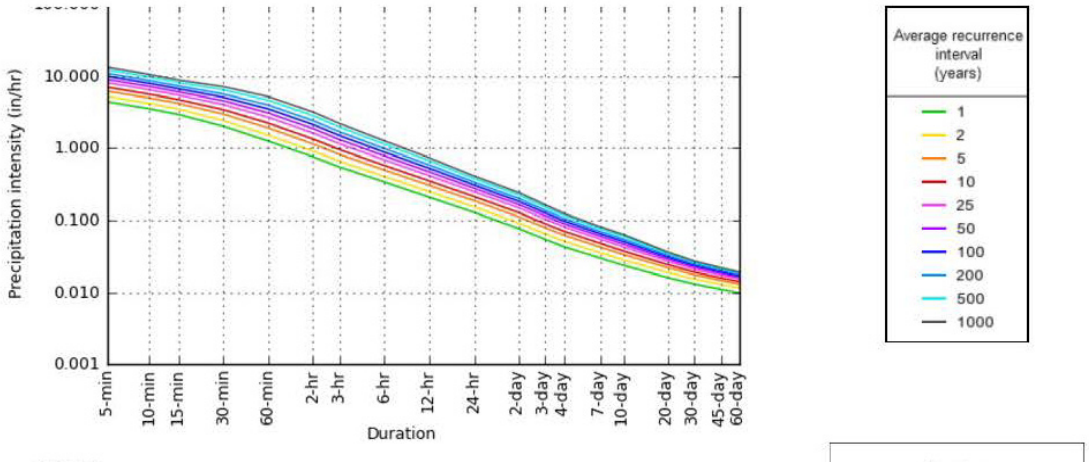
This network of bioretention facilities will terminate at two public parks that will be designed with low impact development techniques that can show the full range of options for green infrastructure. The parks will provide active and passive recreational areas to a variety of age groups.

Green and blue infrastructure create an environmental network

This overall solution is a comprehensive ecological system that connects municipal facilities, retail, and entertainment venues. The project's green spaces create a network of green and blue infrastructure that helps define vehicular and pedestrian traffic, offers active and passive recreation, and supports a regional plan to protect and restore our water and ecological resources.

Hydraulic/Drainage Modeling

As appropriate based on the guidelines provided in the Resource Rain Rainwater Management Guide, we used a combination of the resource rain LID calculation tool spreadsheet, the rational method, WinTR-55, and other modeling software provided by the manufacturer Aquashield. Rainfall intensity data was obtained from the NOAA Atlas 14 application.



The LID calculation tool spreadsheet utilized was limited to 20 sub-drainage areas which would not be enough for our site and the number of bmp's we were implementing. Therefore 2 versions were used and the data was combined. We recommend the existing spreadsheet be modified to accommodate more than 20 sub-drainage areas.

Due to the 30 page limit, we were not able to include the LID calculation spreadsheets, WinTR-55 printouts, and other software documentation. A summary of the result of the improvements is provided below.

	Stay on Volume (SOV)	Annual Stormwater Fee
Existing Site	23,764 CF	$123,840
Redeveloped Site	420,341 CF	$24,768

80% Reduction!!!

Project Costs & Economic Comparison

Since this project is a redevelopment and not a new development, the project costs and economic comparison were calculated based upon the existing storm-water fees that are charged, what the potential savings could be, and time period for return on investment.

Northgate Mall Redevelopment Construction Cost Estimate

ITEM*	UNIT	COST	SUBTOTAL
Aquaswirl Units	4 EA	$39,275.00	$157,100.00
Storm tanks	77,584 CF	$4.25	$329,732.00
Living Machine	1 EA	$750,000	$750,000.00
Permeable Pavers	6120 SF	$5.00	$30,600.00
Bioretention Areas	110,952 SF	$30.00	$3,328,560.00
Stone Seating Areas	17,240 SF	$18.00	$310,320.00
South Splash Park	28,270 SF**	$100.00	$250,000.00
North Playground Park	1 EA	$25,000.00	$25,000.00
Rain Cisterns	151,538 GAL	$1.50	$227,307.00
Green Roof	20,000 SF	$15.00	$300,000.00
TOTAL			**$5,708,619.00**

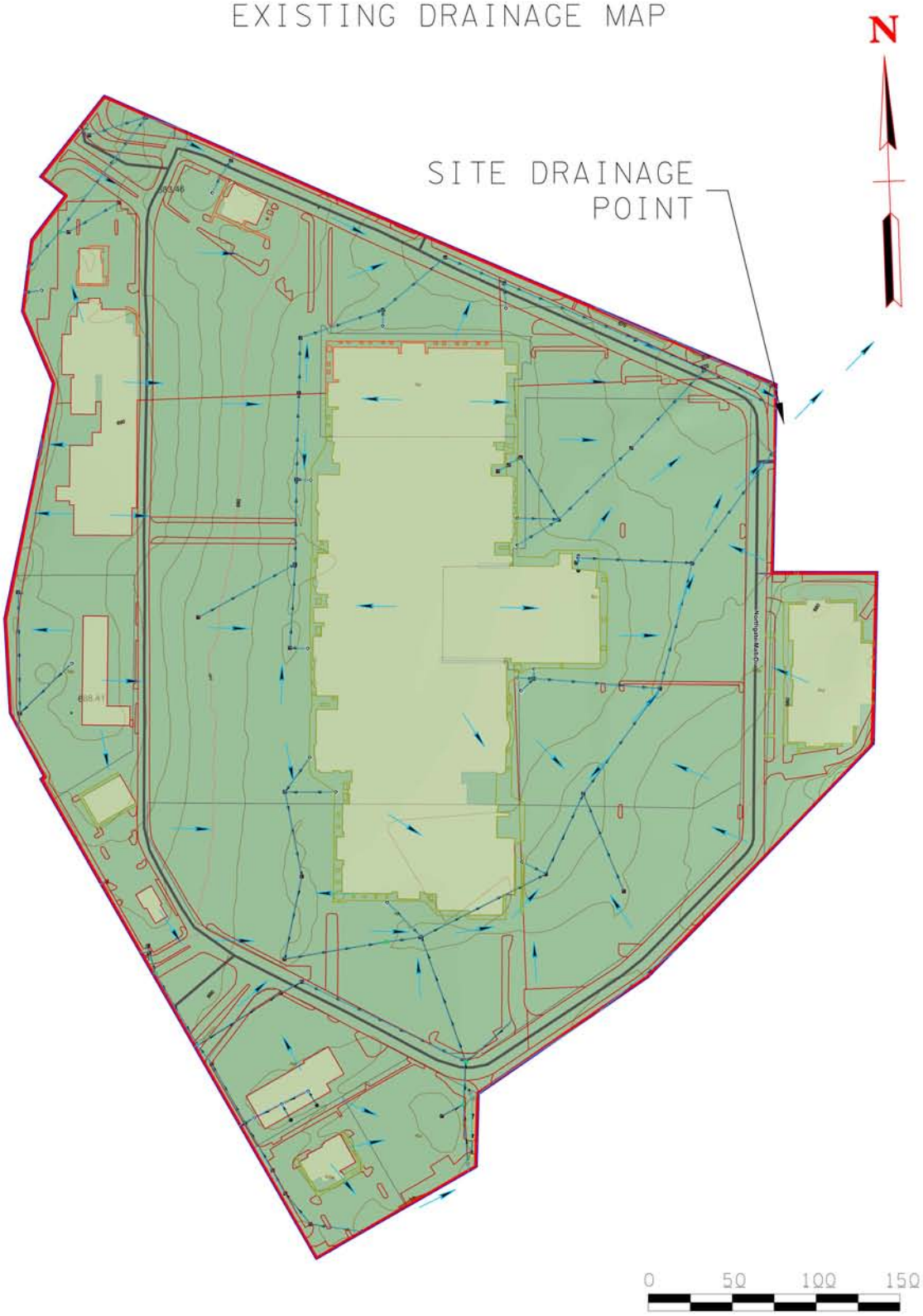
* Items include all incidental materials necessary for installation
** Total park area. Splash pad area 2500 sf

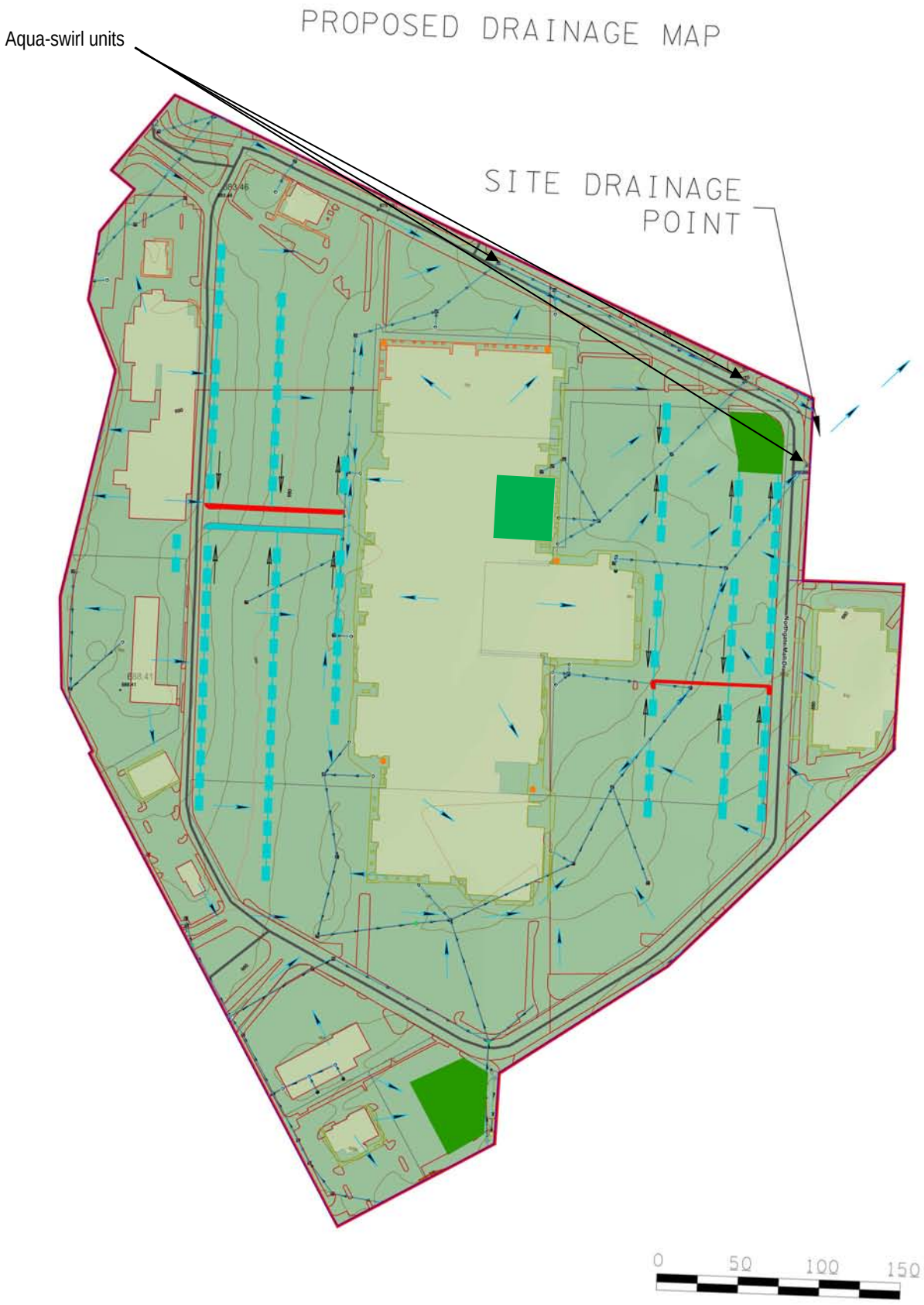
Redevelopment Construction Costs	$5,708,619
Marketable Mitigation Credits	$1,700,000
Annual Stormwater Fee Savings	$99,072
Annual Reduction in water/sewer costs	$150,000

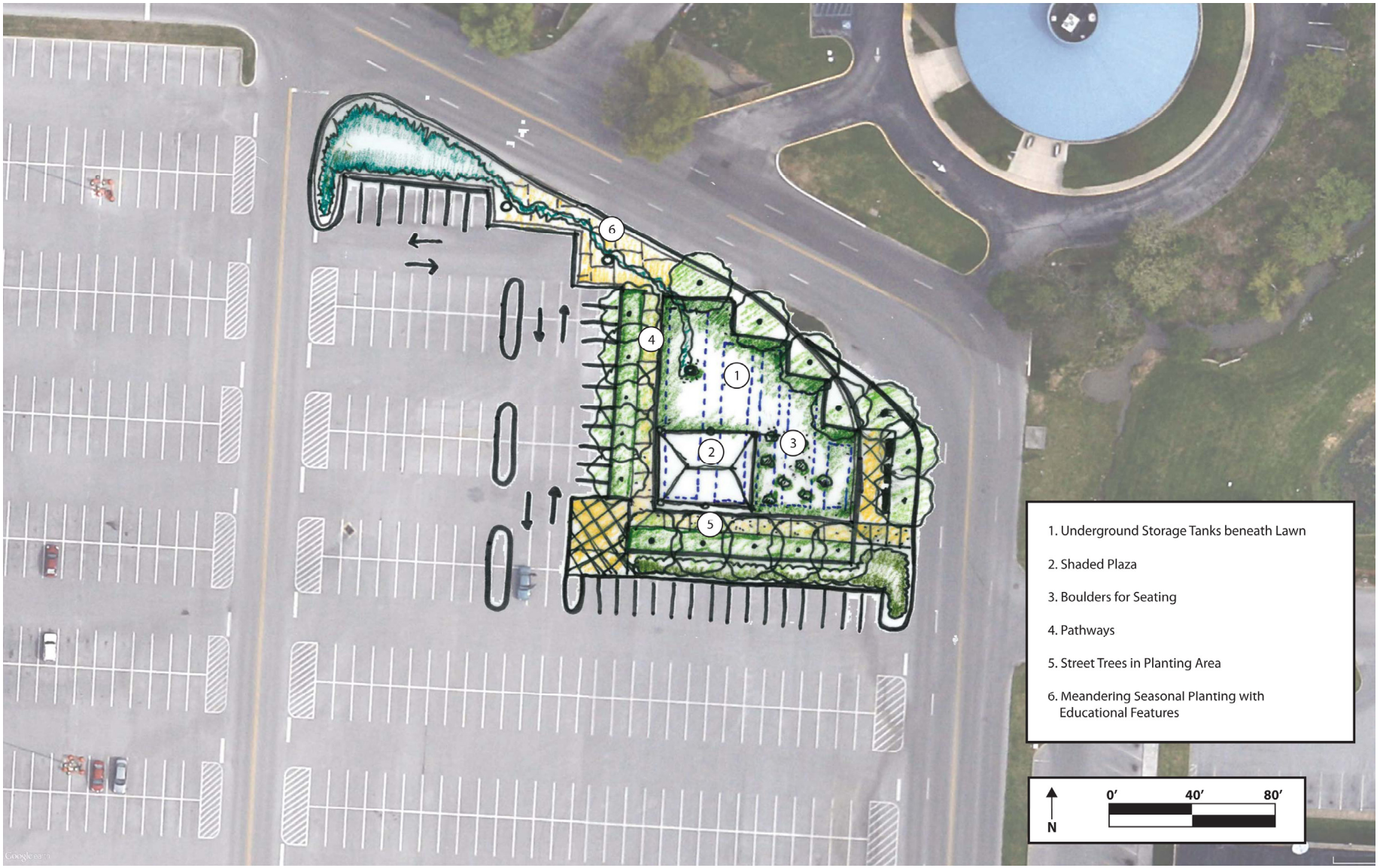
Estimate 20 years to achieve return on investment. This does not take into consideration the economic benefits of increased mall traffic, the ability to charge higher rent, and other factors.


SEARS
CARMIKE 14
CINEMA
JC PENNEY
BELK

EXISTING DRAINAGE MAP




PROPOSED DRAINAGE MAP
Aqua-swirl units
SITE DRAINAGE POINT
0
50
100
150


6
4
1
2
3
5
1. Underground Storage Tanks beneath Lawn
2. Shaded Plaza
3. Boulders for Seating
4. Pathways
5. Street Trees in Planting Area
6. Meandering Seasonal Planting with Educational Features
N
0′
40′
80′


1. Pond Aerator
2. Wetland
3. Meadow
4. Coniferous Buffer
5. Flowering Trees
6. Linear Plaza
7. Outfall
8. Overflow
9. Channels
N
0′
50′
100′

Landscape Plan

The planting design will be determined on a site specific basis. Plants will be selected depending on an number of expected conditions including maintenance, slopes, sun exposure, and flooding frequency, as well as design intent such as the need to buffer or screen objects in the landscape, create shady places to reduce heat island effect, or provide seasonal interest for visual and biological purposes. The planting palette will include native species to the area that can survive the harsh conditions in planting beds of a parking lot that will see fluctuating water conditions. These may include:

Shade Trees

Red Maple – *Acer rubrum*

Cherry Birch – *Betula lenta*

Sycamore – *Platanus occidentalis*

Persimmon – *Diospyros virginiana*

Blackgum – *Nyssa sylvatica*

River Birch – *Betula nigra*

Bald cypress – *Taxodium distichum*

Yellow buckeye – *Aesculus octandra*

Silverbell – *Halesia carolina*

Black cherry – *Prunus serotina*

Ornamental Trees

Ironwood – *Carpinus caroliniana*

Fringe Tree– *Chionanthus virginicus*

PawPaw – *Asimina triloba*

Pagoda Dogwood – *Cornus alternifolia*

Witch-hazel – *Hamamelis virginiana*

Redbud– *Cercis canadensis*

Umbrella Tree – *Magnolia tripetala*

*S*erviceberry – *Amelanchier arborea*

Evergreen Trees

American Holly – *Ilex opaca*

Deciduous Shrubs

Chokeberry – *Aronia arbutifolia*

Buttonbush– *Cephalanthus occidentalis*

Winterberry – *Ilex verticillata*

Spicebush – *Lindera benzoin*

Common Elderberry – *Sambucus Canadensis*

Hardhack – *Spiraea tomentosa*

Arrow-wood – *Viburnum dentatum*

Sweet Shrub – *Calycanthus floridus*

American Hazelnut – *Corylus americana*

Virginia Sweetspire – *Itea virginica*

Ninebark – *Physocarpus opulifolius*

Meadowsweet – *Spiraea latifolia*

Swamp Azalea – *Rhododendron viscosum*

Possumhaw – *Viburnum nudum*

Evergreen Shrubs

Native Brake-Cane – *Arundinaria gigantea*

Perennials

Blue Star – *Amsonia tabernaemontana*

Swamp Milkweed – *Asclepias incarnate*

False Indigo – *Baptisia species*

Mouse Ear Coreopsis – *Coreopsis auriculata*

Rose Mallow – *Hibiscus moscheutos*

Jewelweed –*Impatiens capensis*

Blue Flag Iris – *Iris virginica*

Cardinal Flower – *Lobelia cardinalis*

Royal Fern – *Osmunda regalis*

Moss Pinks – *Phlox subulata*

Rudbeckia – *Rudbeckia fulgida*

Goldenrod– *Solidago rugosa*

Ironweed – *Vernonia novaboracensis*

Lady Fern – *Athyrium felix-femina*

Butterflyweed – *Asclepias tuberosa*

Turtlehead – *Chelone glabra*

Lanceleaf Tickseed – *Coreopsis lanceolata*

Texas Star – *Hibiscus coccineus*

Swamp Iris –*Iris versicolor*

Gayfeather – *Liatris spicata*

Cinnamon Fern – *Osmunda cinnamomea*

Garden Phlox – *Phlox paniculata*

Pickerelweed –*Pontedara cordata*

Cutleaf Coneflower– *Rudbeckia laciniata*

Stoke's Aster – *Stokesia laevis*

Ornamental Grasses

River Oats – *Chasmanthium latifolium*

Panic Grass – *Panicum virgatum*

Indiangrass – *Sorghastrum nutans*

Sedges and Rushes

Lurid Sedge – *Carex lurida*

Woolgrass - *Scirpus cyperinus*

Fringed Sedge – *Carex crinita*

Soft Rush –*Juncus effuses*