SUSTAINABLE DEVELOPMENT INFRASTRUCTURE

Bonny Oaks

Chattanooga, Tennessee

resource: Rain
Low Impact Development Design Challenge
TEAM # 12361

BONNY OAKS - SUSTAINABLE DEVELOPMENT INFRASTRUCTURE

Bonny Oaks is a 6 acre mixed-use development site fronting Bonny Oaks Drive to the south, South Chickamauga Creek and greenway to the east, undeveloped land to the north, and an active railroad line to the west. It combines the opportunities for 140 condominium and townhome multifamily residential units, live work office units, commercial retail and restaurant development, an urban food forest, and restored meadows and groves of woodland. It also links to surrounding recreational opportunities and multi-modal transportation options. By using a model of sustainable infrastructure for the Bonny Oaks Development we create an exciting high density development that embraces multiple functions including:

Management of storm water with green infrastructure - 200,000 gallons of rainwater harvested in cisterns and aqueducts

The Bonny Oaks development uses green infrastructure and a strong design expression to move stormwater through a series of interconnected water quality tools on the site. The treatment starts with rooftop gardens that function as usable outdoor space for the residents. Hard surface areas on the roof are captured through gutter systems and transferred to a large stone cistern that serves as a focal point for the community. The large stone cistern is further connected through an aqueduct that feeds into water silos placed in the central plaza between buildings. Water stored in the silos is utilized for irrigation and reclaimed grey water use in the buildings. Overflow from the aqueduct system and surface runoff from the plaza and streets is then captured in a series of porous pavers, infiltration trenches, and bioretention. The last downstream treatment of water is achieved with dispersion into restored meadows and woodlands which act as a large buffer zone between the development and the South Chickamauga Creek. The implementation of all these tools results in a complete on site treatment of storm water for a 1" rainfall event greatly reducing the need for large inlets, pipes and concrete gutters and channels.

Enhanced environmental quality - 96,000 s.f. of restored meadow and woodlands using native plants

The Bonny Oaks development integrates into the natural environment around it and enhances the outdoor experience of its residents and visitors. Restored woodlands and wildflower meadows envelope the edge of the project and act as a water quality buffer to the South Chickamauga Creek. Biodiversity is increased with the establishment of native and drought tolerant plants and wildlife habitat throughout the project, giving a home to beneficial birds, insects, and soil micro-organisms. Canopy trees, infiltration trenches, bioretention ponds,v and rooftop gardens provide shade and transpiration to clean the water and air and reduce the impact of the urban heat island (increased temperatures found in areas predominantly covered with concrete and asphalt.) Healthy, organic food is grown on site with raised agricultural beds that utilize rainwater harvested from surrounding rooftops and soil composted from on-site waste. This reduces the cost and environmental impact of transporting food long distances.

BONNY OAKS - SUSTAINABLE DEVELOPMENT INFRASTRUCTURE

Improved multi-modal transportation - 4.0 miles of hiking, biking and paddling (Sterchi Farm Section of Greenway)

Bonny Oaks is connected to several means of multi-modal transportation opportunities. Good connection to the county arterial highway TN 153 is within a half mile of the site. The majority of automobiles are parked in lower level garages, allowing for pedestrian plaza and green space to surround proposed buildings. Traffic calming is achieved with vegetated medians and stamped pedestrian crossings. A traffic circle slows down the travel of automobiles through the site and functions as an artistic water gauge. With the South Chickamauga Creek greenway adjacent to the site, there are pedestrian, bicycle, and watercraft modes of transportation available to residents of Bonny Oaks development, providing a long distance connection all the way to the heart of downtown Chattanooga. These modes of transportation also serve to bring people from the surrounding communities to the commercial establishments mixed into the property. Additional recreational and health benefits are found in the pedestrian pathways and bicycle routes designed into the site and connecting to its surrounding environment.

Promoting a sense of community and public education - 5 new ways to look at rain: aqueduct, terraced rain garden, interactive forebay, porous streetscape, street planter box

Green infrastructure creates beautiful and functional spaces. People connect to beautiful spaces. This connection becomes an important part of the sustainability of a space. When people care about a space they will maintain it and steward its resources. The Bonny Oaks development has beautiful and functional spaces that encourage community interaction and commerce. The site is designed to move from an area of public commerce along Bonnie Oaks Drive into an open air community market and traffic circle. The traffic circle functions as a focal point to connect greenway, private street and plaza. Interaction with environmental features throughout the site create ample opportunity for educational and recreational experiences.

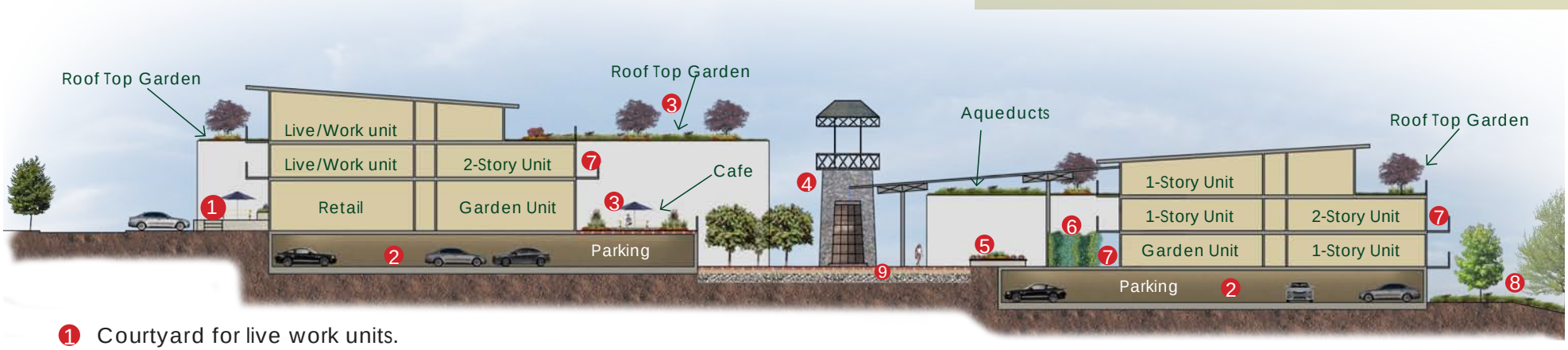
Economic benefits - 21,470 s.f. of vibrant commercial space retail, office, outdoor market

Investment in the green infrastructure creates market value for the Bonny Oaks property. Some of that market value comes from the increased interest in investors to purchase or lease property that is framed by aesthetically pleasing landscape and a clean environment. Market value also comes from the reduction of energy demands for sustainably designed buildings and reduction of domestic water use from the benefits of harvesting rainwater on site. By implementing a high density of mixed use development the infrastructure cost of roads and utilities per unit is greatly reduced. Stormwater fee assessments for commercial properties can be decreased due to reduced impact on regional stormwater facilities. Residents of Bonny Oaks will benefit economically from on-site food production, reduced travel costs and energy demands, and increased recreational and health options.

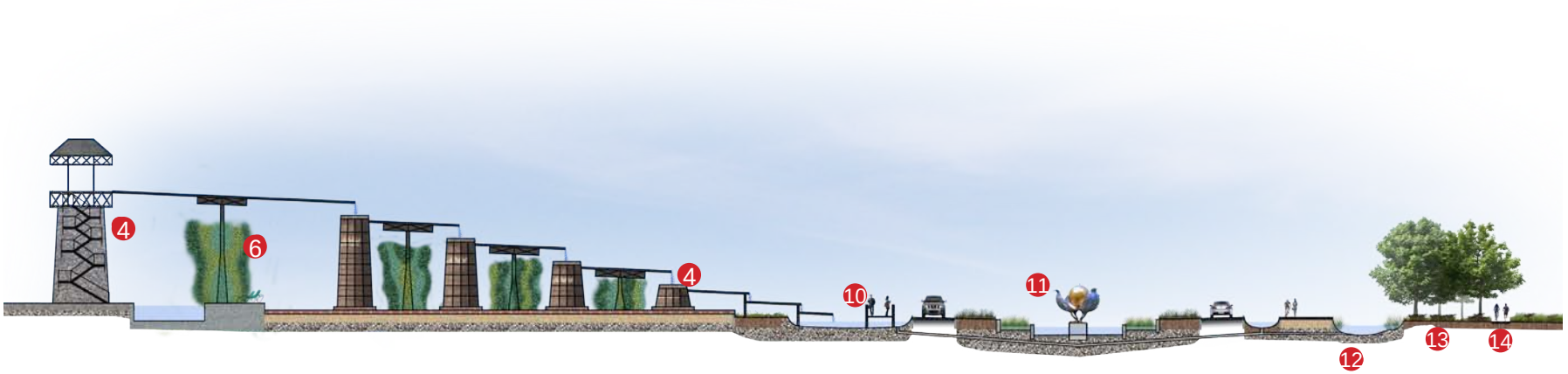
MASTER PLAN


BUILDING ONE
24 1-Story Live/Work Units
10 1-Story Garden Flats
14 2-Story Units
48 Total Units
BUILDING TWO
47 1-Story Units (Courtyard Side)
12 1-Story Flats (River Side)
12 2-Story Units (River Side)
7 2-Story Townhomes (Drive)
78 Total Units
BUILDING TWO
3-Story
Residential
BUILDING ONE
3-Story
Residential & Retail
Future Development
NORTH
SEE NEXT PAGE FOR NUMBER KEY

NORTH / SOUTH SECTION VIEW THROUGH BUILDINGS



1. Courtyard for live work units.
2. Lower level parking and on-site recycling center
3. Green roof/ rooftop garden
4. Water silo and aqueduct system (contains all roof drainage)
5. Urban food forest in raised bed systems
6. Green wall creates living vertical panel
7. Private patio space for residential units
8. On site soil building (compost facility)
9. Food forest and landscape irrigated from water silos
10. Bridge over aqueduct overflow pool
11. Water sculpture
12. Bioretention with interaction forebay
13. Restored woodlands and meadow edge
14. Natural surface trail
15. Greenway connection (multi use trail)
16. Destination node on greenway with public art and educational signage
17. Existing greenway
18. Watercraft launch , kayak rental, and creek access
19. Pedestrian crossing with stamped concrete
20. Infiltration trench with adjacent porous pavers for on street parking
21. Planter box to treat stormwater in median
22. Public art in retail plaza
23. Restaurant to anchor building corner
24. Kayak and coffee shop and open air farmer market
25. Potential bus stop location for future route
26. Potential future light rail connection compatible with freight routes



4 Water silo and aqueduct system (contains all roof drainage)

6 Green wall creates living vertical panel

10 Bridge over aqueduct overflow pool

11 Water sculpture

12 Bioretention with interaction forebay

13 Restored woodlands and meadow edge

14 Natural surface trail

EAST/ WEST SECTION VIEW THROUGH PLAZA

12 Bioretention with interaction forebay

13 Restored woodlands and meadow edge

14 Natural surface trail

16 Destination node on greenway with public art and

17 Existing Greenway

18 Watercraft launch , kayak rental, and creek access

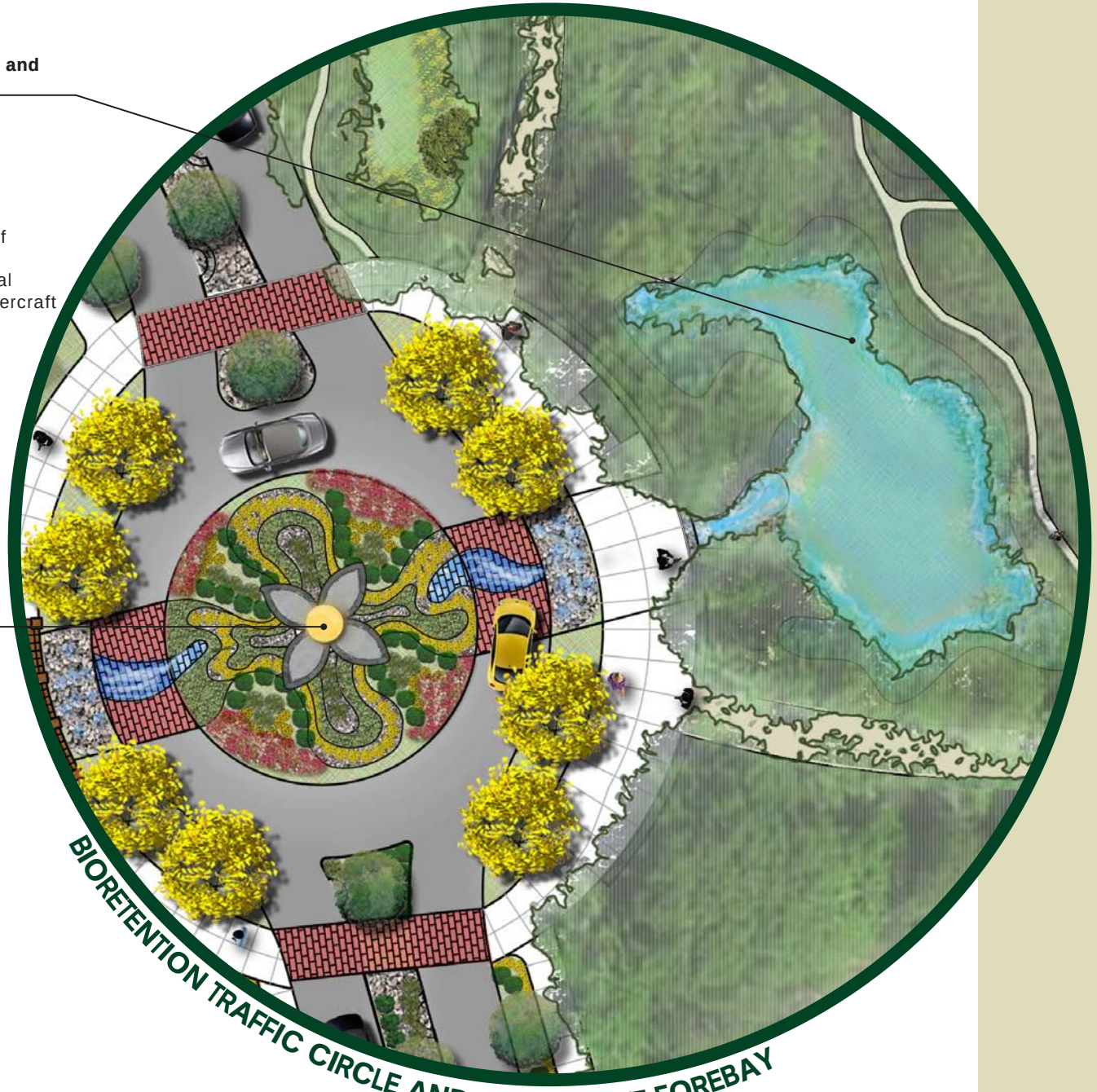
EAST / WEST SECTION
VIEW TO CREEK

Bioretention with interactive forebay, and restored woodland and meadow habitat

-Bioretention filters water into naturalized buffer zone
-Restored wildlife habitat creates a home for beneficial birds, insects, amphibians, and soil microorganisms
-Plaza edge is framed with education signage and pockets of space designed for public interaction with the environment
-Greenway connection provides recreational and multi-modal transportation opportunities for pedestrian, bicycles, and watercraft

Traffic circle with bioretention and water gauge sculpture

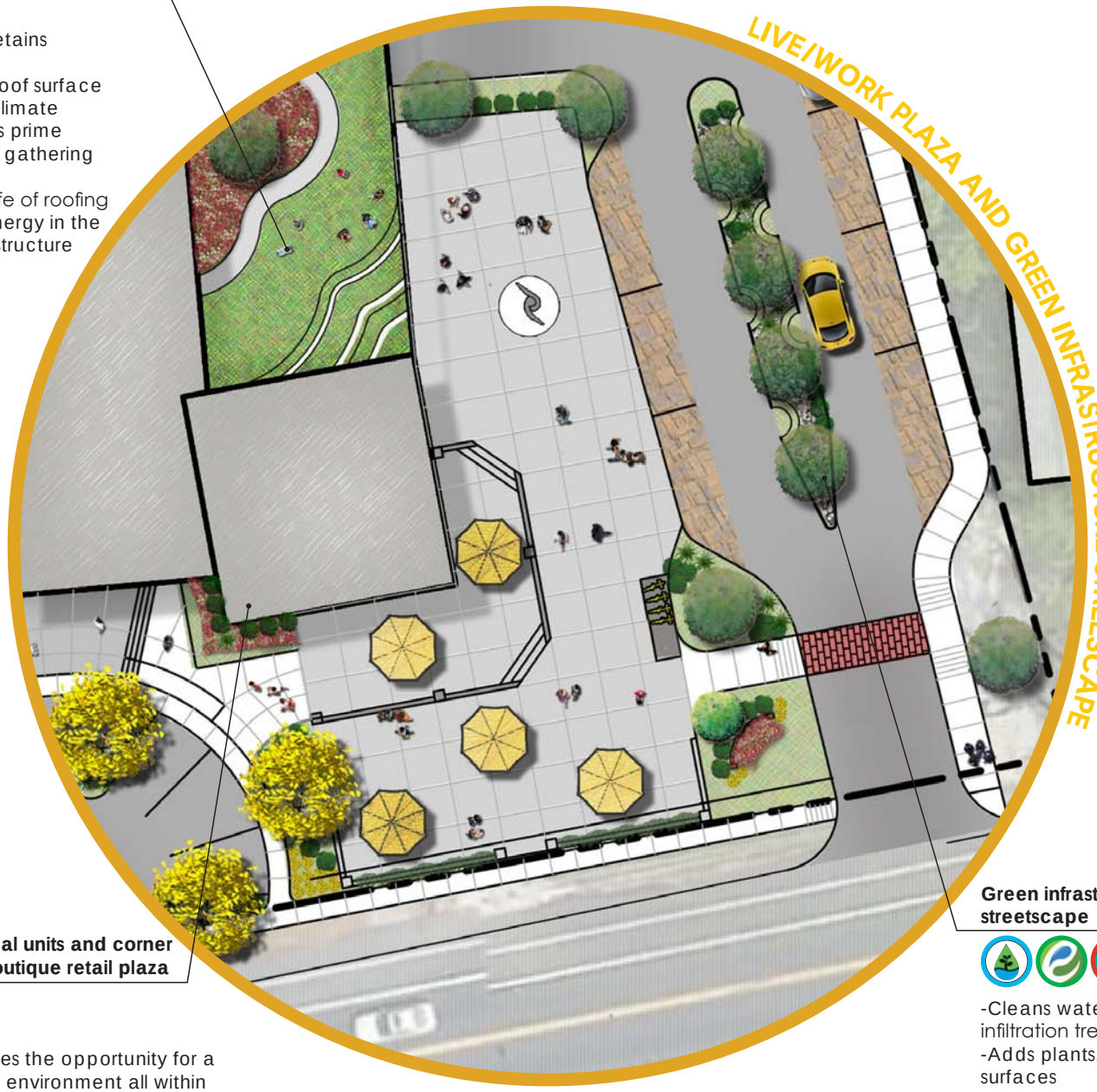
-Cleans water
-Adds plants/biodiversity
-Artistic focal point for Bonny Oaks Development
-Improved connection for bikes and pedestrians
-Traffic calming is achieved with stamped pavers
-Simulating water movement under the roadway



BIORETENTION TRAFFIC CIRCLE AND INTERACTIVE FOREBAY

Green roofs/rooftop gardens

-Vegetated surface retains stormwater
-Plant material cools roof surface and improves micro-climate
-Roof space becomes prime overlook and societal gathering space
-Green roof extends life of roofing material and saves energy in the heating and cooling structure



Work/Live residential units and corner restaurant/local boutique retail plaza

-Mixed-use promotes the opportunity for a "live, work, & play" environment all within walking distance
-The local economy is stimulated with investment dollars
-A sense of community is strengthened with public gathering space

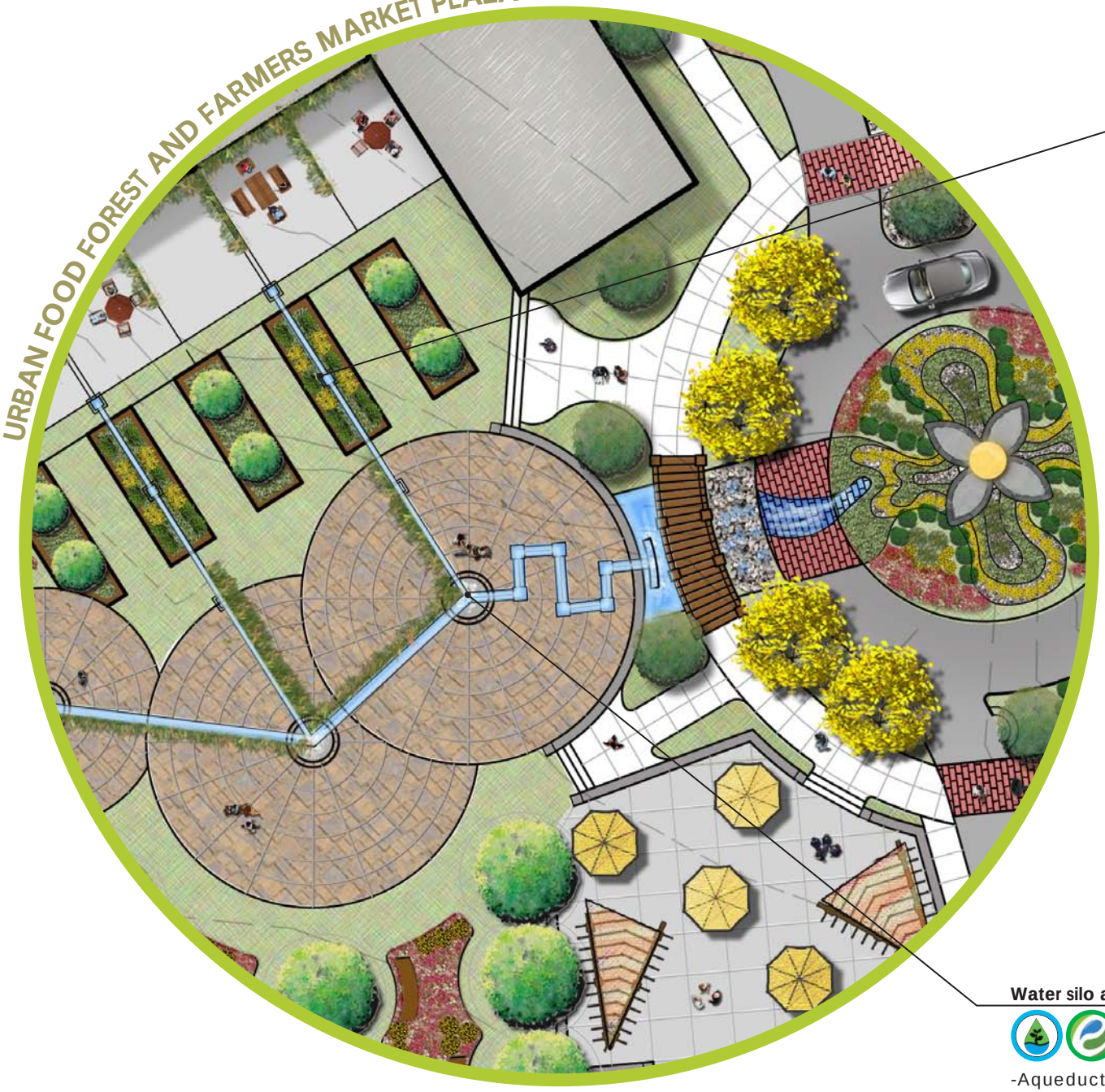
Green infrastructure integrated into streetscape

-Cleans water with porous pavers and infiltration trench
-Adds plants/biodiversity and shades hard surfaces
-Promotes pedestrian and bicycle use with multi-use trail and bicycle transit station
-On-street parking, medians, and concrete stamped crosswalks promote traffic calming
-Streetscape becomes a visual enhancement for the community

STREET PERSPECTIVE FROM BONNY OAKS DRIVE

- CORNER RESTAURANT AND BOUTIQUE RETAIL
- LIVE WORK UNITIS AND OFFICE SPACE
- GREEN INFRASTRUCTURE BUILT INTO STREETSCAPE TO CLEAN STORMWATER

URBAN FOOD FOREST AND FARMERS MARKET PLAZA



Urban food forest

-Residents have opportunity to grow food
-Farmer's Market provides economic outlet
-Harvested rainwater used for irrigation

Water silo and aqueduct system

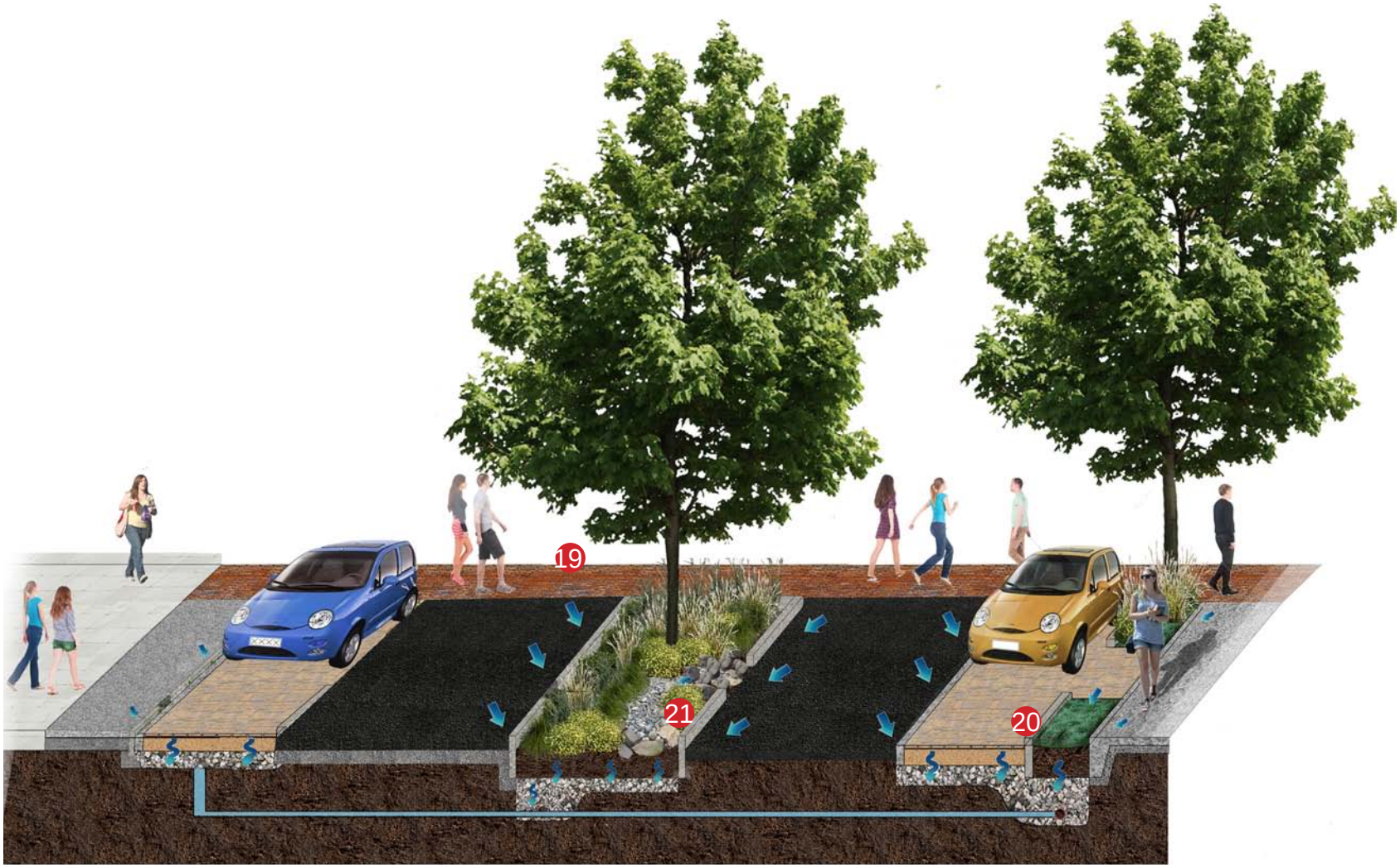
-Aqueduct becomes community focal point
-Harvest rainwater for reuse and provides opportunities to cleans stormwater
-Dynamic view of system for public education opportunities

12 Bioretention with interaction forebay

13 Restored woodlands and meadow edge

14 Natural surface trail

BIORETENTION WITH INTERACTIVE FOREBAY AND RESTORED WOODLANDS / MEADOW



19 Pedestrian crossing with stamped concrete

20 Infiltration trench with adjacent porous pavers for on street parking

21 Planter box to treat stormwater in median

GREEN INFRASTRUCTURE ON PRIVATE ACCESS DRIVE

4 Water silo and aqueduct system (contains all roof drainage)

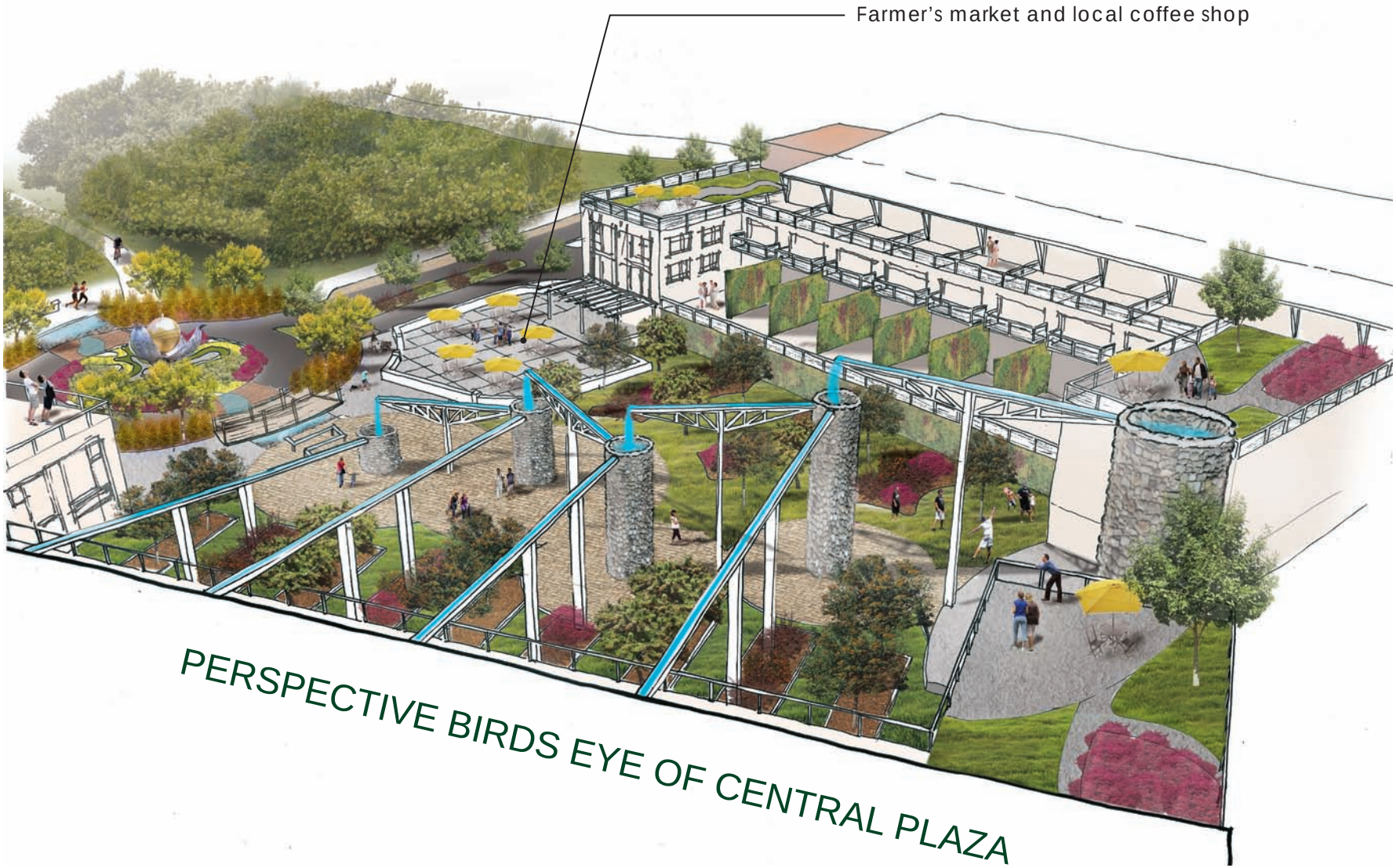
5 Urban food forest in raised bed systems

6 Green wall creates living vertical panel

7 Private patio space for residential units

9 Food forest and landscape irrigated from water silos

CENTRAL PLAZA WITH AQUEDUCT AND URBAN FOOD FOREST



PERSPECTIVE BIRDS EYE OF CENTRAL PLAZA

4165 Bonny Oaks Stormwater Report

This report provides a summary of the stormwater management approach for the 4165 Bonny Oaks site.

General Description

The Bonny Oaks site is a 6 acre tract of land that is currently serving as a used car lot on the more flat portions of the site near the road and is undisturbed vegetation in the sloped portions of the site about midway through the tract and proceeding toward the northeast. The furthest northeast portion of the tract is a power line easement, so it is mowed regularly. The project proposed for this site has been designed with stormwater management as a focal point of the development. The attached stormwater drainage area map depicts the drainage areas and the following description discusses each of the areas and how stormwater will be managed.

- Building rooftops: The stormwater runoff from the building rooftops will be harvested and beneficially reused for irrigation, gray water, or as a water feature. The rooftop patios will also be equipped with gardens to utilize some of the stormwater and provide a community focus.

- Sub-Drainage ID 1: This area is the road frontage and entrance portion of the project. Stormwater runoff is managed through tree plantings, stormwater planter boxes, and pervious pavement in the parallel parking areas. This area drains into Sub-drainage ID 3.

- Sub-Drainage ID 2: This area is the central courtyard of the project and includes patios, fruit orchard, and water features. The water features and orchard will be watered from the rooftop rainwater harvesting system. Stormwater runoff from this area is managed through a bioretention area (No. 4) in the middle of the roundabout.

- Sub-Drainage ID 3: This area is the southeastern edge of the roundabout and is mostly vegetated landscaping and a bioretention area. The bioretention area (No. 3) manages stormwater runoff from this drainage area and the additional runoff from Sub-Drainage ID 1.

- Sub-drainage ID 4: This is the northern entrance and parking area. Stormwater runoff is managed through tree plantings, stormwater planter boxes, and pervious pavement in the parallel parking areas.

- Sub-Drainage Area 5: This is the north entrance into the parking deck. The stormwater runoff from this area is managed through a bioretention area (No. 1) to the northeast.

- Sub-Drainage ID 6: This area is the northeastern edge of the roundabout and is mostly vegetated landscaping and a bioretention area. The bioretention area (No. 2) manages stormwater runoff from this drainage area.

Runoff Reduction Strategy

The main runoff reduction strategy utilized was minimization of disturbed area. The proposed project only disturbs 4.33 acres, which maintains 28% of the site as undisturbed. This undisturbed portion is the steeper slopes on the site and is already heavily vegetated.

Infiltration on the site is fair. An infiltration rate of 1.0”/ hour was assumed.

Managing Stay-on-Volume (SOV)

This project site requires management of 1.6” of rain. The LID Tool worksheets for this project are attached. The worksheets indicate that the SOV for each of the Sub-Drainage IDs is met, except for Sub-Drainage ID 1. The permeable pavement in this area only provides management of about 0.8” of rain. Sub-Drainage ID 1 drains into Sub-Drainage ID 3, which is able to manage the stormwater from this area plus the additional 0.8” of rainfall from Sub-Drainage ID 1. Therefore, the SOV of 11,794 cubic feet for the site has been met, and even exceeded (12,802 cubic feet), by the green infrastructure. Since the SOV has been met, no water quality improvements are needed.

Peak Flows

A narrative of the peak flow calculation methodology, software used, and results is provided below.

<u>NRCS Unit Hydrograph Method for Peak Rate Calculation</u>

NRCS developed a system to estimate peak runoff rates and runoff hydrographs using a dimensionless unit hydrograph derived from many natural unit hydrographs from diverse watersheds throughout the country (NRCS Chapter 16, 1972). The NRCS methodologies are available in several public domain computer models.

PCSWMM was the software package used for the peak rate calculation of the Bonny Oaks project. PCSWMM was selected to perform the calculation because it is “a fully featured urban drainage system modeling package, with no limitations on model size or complexity. PCSWMM contains a complete GIS system (no third party software required) tailored to urban drainage modeling which supports most projections, datums, and ellipsoids, provides interaction with a large number of GIS formats, as well as topological operations and querying. PCSWMM provides advanced versions of all of the standard urban drainage modeling visualization techniques, including animated hydraulic grade line and energy grade line profiles, plan-view static and animated thematic rendering, powerful plotting tools, as well as on-the-fly statistical, calibration and error analysis” (Computational Hydraulics International, 2014).

Runoff is calculated using the NRCS method with only a curve number (based on land cover type and the hydrologic soil group) and rainfall depth. Curve numbers (CN) and additional information on the development of the method may be found in “Urban Hydrology for Small Watersheds” published by the Soil Conservation Service, now NRCS, in 1986. Recommended CN values for use in Chattanooga are provided in Table 7-5 of the Chattanooga Rainwater Management Guide.

Based on the cover type and hydrologic soil group (gathered from the NRCS Web Soil Survey) of the site’s drainage area, the composite CN was determined to be 80.

Discharge Location

The Bonny Oaks project site contains multiple subareas and discharge points. This project has been evaluated for peak rate control “as a whole” such that the combined discharge rate at all discharge locations from the project site is not greater than the combined discharge rate before development. Thus, one “ultimate” discharge location was placed at the lowest elevation of the site in the northeast corner. In addition, the discharge location was placed here because of the limitation of the topographic data outside of the Bonny Oaks site provided for this project.

CN Adjustment to Reflect SOV Capture

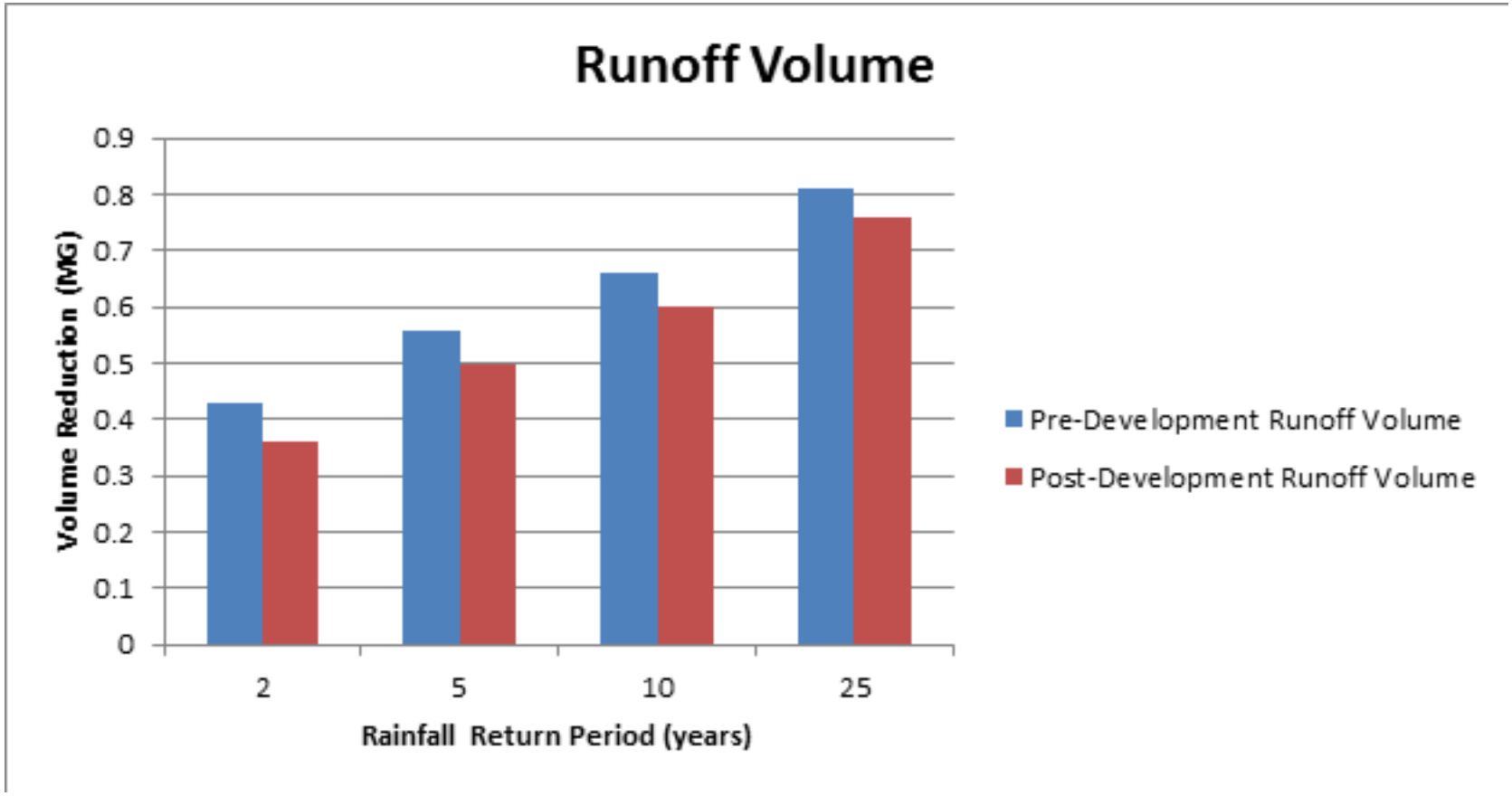
To account for the impacts on peak rate reduction through the application of LID measures on a project site, an adjustment was made to the CN assigned to disturbed areas managed by a BMP. The CN value is adjusted to reflect both the volume captured in various BMPs (SOV) as well as any infiltration that occurs over a defined time period during a large storm. The CN adjustment was calculated in “Worksheet 4” of the “LID Tool” provided in the Chattanooga Rainwater Management Guide. As a result, the adjusted CN values for the 10, 25, and 100-year, 24-hour storm events are 71, 72, and 73, respectively.

Peak Flows

Using the Curve Number Method within PCSWMM, the Bonny Oaks project's post-development peak rate is less than the pre-development peak rate of discharge for all rainfall return periods.

Rainfall Return Period (yr)	Peak Flow (cfs)	
	Pre-Development	Post-Development
2	16.6	15.8
5	23.1	22.3
10	28.2	27.4
25	36.2	35.4

In addition, the total stormwater runoff from the site has been reduced by about 10%



Cost Comparison

The cost for the green infrastructure as compared to traditional stormwater management is about 23% less, as shown in the cost tables below.

Green Infrastructure Cost				
GI Description	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Bioretention	8,705	Sq. ft.	$16.00	$139,280.00
Bioswales	0	Linear ft.	$15.00	$0.00
Tree Boxes	6	Each	$5,500.00	$33,000.00
Pervious Pavement	3,905	Sq. ft.	$10.00	$39,050.00
Rainwater Harvesting	1	Each	$60,000.00	$60,000.00
TOTAL CONSTRUCTION COST				$271,330.00

Traditional Stormwater Infrastructure Cost				
GI Description	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Curb and Gutter	3,500	Linear ft.	$16.00	$56,000.00
24" Dia. RCP	2,000	Linear ft.	$95.00	$190,000.00
Catch Basins	20	Each	$4,000.00	$80,000.00
Detention Basin	0.2	Acre	NA	$25,000.00
				$0.00
TOTAL CONSTRUCTION COST				$351,000.00

Summary								
Sub-Drainage ID	**Total Disturbed Area** (ft^2)	**Total Disturbed Impervious Area** (ft^2)	**Sub-Drainage Area SOV** (ft^3)	**Volume Credit** (ft^3)	**Net Sub-Drainage Area SOV** (ft^3)	**Loading Ratio**	**BMP Capture Volume** (ft^3)	**Capture > SOV?**
1	37,934	35,999	4,765	132	4,633	19	2,322	NO
2	43,893	26,132	3,946	78	3,868	10	4,082	YES
3	9,320	5,795	788	24	764	2	3,600	YES
4	10,514	6,431	930	66	864	3	985	YES
5	18,707	7,812	1,313	0	1,313	3	1,414	YES
6	4,571	2,565	352	0	352	3	400	YES
7	0	0	0	0	0	N/A	0	N/A
8	0	0	0	0	0	N/A	0	N/A
9	0	0	0	0	0	N/A	0	N/A
10	0	0	0	0	0	N/A	0	N/A
11	0	0	0	0	0	N/A	0	N/A
12	0	0	0	0	0	N/A	0	N/A
13	0	0	0	0	0	N/A	0	N/A
14	0	0	0	0	0	N/A	0	N/A
15	0	0	0	0	0	N/A	0	N/A
16	0	0	0	0	0	N/A	0	N/A
17	0	0	0	0	0	N/A	0	N/A
18	0	0	0	0	0	N/A	0	N/A
19	0	0	0	0	0	N/A	0	N/A
20	0	0	0	0	0	N/A	0	N/A
Totals	124,939	84,734	12,094	300	11,794		12,802	

PREADSHEET TOOL 1: SOV, BMP AREA AND PEAK FLOW RATE ESTIMATES

Project Name: BONNY OAKS
Date Prepared: 6/20/2014
Prepared by: 12361

WORKSHEET 1: SOV and BMP AREA

=> Denotes input by user

Total Parcel Area	6.00	ac
otected Areas		
5.2.1 Area of Protected Undisturbed and Healthy Soils	3.14	ac
5.2.1.1 Area of Minimized Land Disturbance	0.00	ac
5.2.1.2 Area of Protected Soils/Steep Slopes	0.00	ac
5.2.2 Area of Protected Natural Flow Paths	0.00	ac
5.2.3 Area of Protected/Enhanced Riparian Corridors	0.00	ac
5.2.4 Area of Protected/Preserved Vegetation	0.00	ac
Total Proteced Area	3.14	ac
-Managing BMPs		
5.3.8 Green Roof	0.00	
5.3.1 Pervious Pavement Sidewalk	0.00	ac
Total Area of Self -Managing BMPs	0.00	ac

Stormwater Management Area =	2.87	ac
Stormwater Management Area =	124939	ft^2
CAPTURE AREA (Sum of Disturbed Land Areas below) =	124939	ft^2

Runoff Coefficients, Rv for Design Rainfall					
Land Use Type	**Surface Condition**		**1.0**	**1.6**	**2.1**
-	-	-	-	-	-
Clayey Soils	Pervious		0.21	0.24	0.27
Flat Roof	Impervious		0.85	0.88	0.90
Large Impervious	Impervious		0.98	0.99	0.99
Pitched Roof	Impervious		0.97	0.99	0.99
Sandy Soils	Pervious		0.03	0.05	0.08
Small Impervious	Impervious		0.70	0.79	0.85
Typical Urban Soils	Pervious		0.12	0.15	0.18

- Large impervious includes parking lots with curbs, roads with curbs, highways, etc.
- Small impervious includes roads without curbs, small parking lots without curbs, and sidewalks.

SOV DESIGN RAINFALL (in) = **1.6**

TARGET LOADING RATIO 8 (See Ch. 5 for details)

INITIAL TARGET BMP AREA = **10,592** ft^2

Sub-Drainage ID per BMP	Land Use Type	Surface Condition	Disturbed Land Area (ft^2)	Disturbed Land Area (ac)	Rv Value, from Table	Stay on Volume (ft^3)
1a	Large Impervious	Impervious	35,999	0.83	0.99	4,752
1b	Sandy Soils	Pervious	1,935	0.04	0.05	13
2a	Large Impervious	Impervious	26,132	0.60	0.99	3,449
2b	Clayey Soils	Pervious	14,934	0.34	0.24	478
2c	Sandy Soils	Pervious	2,827	0.06	0.05	19
3a	Large Impervious	Impervious	5,795	0.13	0.99	765
3b	Sandy Soils	Pervious	3,525	0.08	0.05	24
4a	Clayey Soils	Pervious	2,113	0.05	0.24	68
4b	Large Impervious	Impervious	6,431	0.15	0.99	849
4c	Sandy Soils	Pervious	1,970	0.05	0.05	13
5a	Clayey Soils	Pervious	8,273	0.19	0.24	265
5b	Large Impervious	Impervious	7,812	0.18	0.99	1,031
5c	Sandy Soils	Pervious	2,622	0.06	0.05	17
6a	Large Impervious	Impervious	2,565	0.06	0.99	339
6b	Sandy Soils	Pervious	2,006	0.05	0.05	13
	-	-		0.00	-	-

note: Runoff Volume based on Small Storm Hydrology Method, where Rv is the ration of runoff to rainfall volume.

TOOL 2 - VOLUME CREDIT

Project Name: BONNY OAKS
Date Prepared: 6/20/2014
Prepared by: 12361

WORKSHEET 2: Restorative Credits

=> Denotes input by user

Restorative Volume Credit Worksheet

Sub-Drainage ID	Sub-Drainage SOV (ft^3)	Restorative Practice Credit Type	Area (ft^2)	# of Trees	Volume Credit (ft^3)	Total Volume Credit (limit to maximum of 25% of SOV) (ft^3)	Net Drainage Area SOV (ft^3)
1	4,765	Tree Planting - Deciduous		22	132	132	4,633
		None			0		
		None			0		
2	3,946	Tree Planting - Deciduous		13	78	78	3,868
		None			0		
		None			0		
3	788	Tree Planting - Deciduous		4	24	24	764
		None			0		
		None			0		
4	930	Tree Planting - Deciduous		11	66	66	864
		None			0		
		None			0		
5	1,313	None			0	0	1,313
		None			0		
		None			0		
6	352	None			0	0	352
		None			0		
		None			0		
7	0	None			0	0	0
		None			0		
		None			0		

TOOL 3 - BMP SIZING TOOL

Project Name: BONNY OAKS
Date Prepared: 6/20/2014
Prepared by: 12361

WORKSHEET 3: BMP SIZING

=> Denotes input by user

Sub-Drainage ID	BMP Type	Runoff Storage Type	Mid-height Area (ft^2)	Depth of Storage (ft)	Storage Capacity (%)	Storage Volume (ft^3)	BMP Surface Area (ft^2)	BMP Capture Volume (ft^3)	Net Drainage Area SOV (ft^3)	Loading Ratio
1	**Pervious Pavement**	Surface			0%	0	1,935	2,322	4633	19
		Soil			0%	0				
		Stone	1,935	3	40%	2,322				
2	**Bioretention**	Surface	2,551	0.5	100%	1,276	2,551	4,082	3868	10
		Soil	2,551	1.5	20%	765				
		Stone	2,551	2	40%	2,041				
3	**Bioretention**	Surface	3,000	0.5	100%	1,500	3,000	3,600	764	2
		Soil	3,000	1.5	20%	900				
		Stone	3,000	1	40%	1,200				
4	**Pervious Pavement**	Surface			0%	0	1,970	985	864	3
		Soil			0%	0				
		Stone	1,970	1.25	40%	985				
5	**Bioretention**	Surface	2,356	0	0%	0	2,356	1,414	1313	3
		Soil	2,356	1.5	20%	707				
		Stone	2,356	0.75	40%	707				
6	**Bioretention**	Surface	800	0	0%	0	800	400	352	3
		Soil	800	1.5	20%	240				
		Stone	800	0.5	40%	160				
7	**-**	Surface			0%	0	0	0	0	N/A
		Soil			0%	0				
		Stone			0%	0				

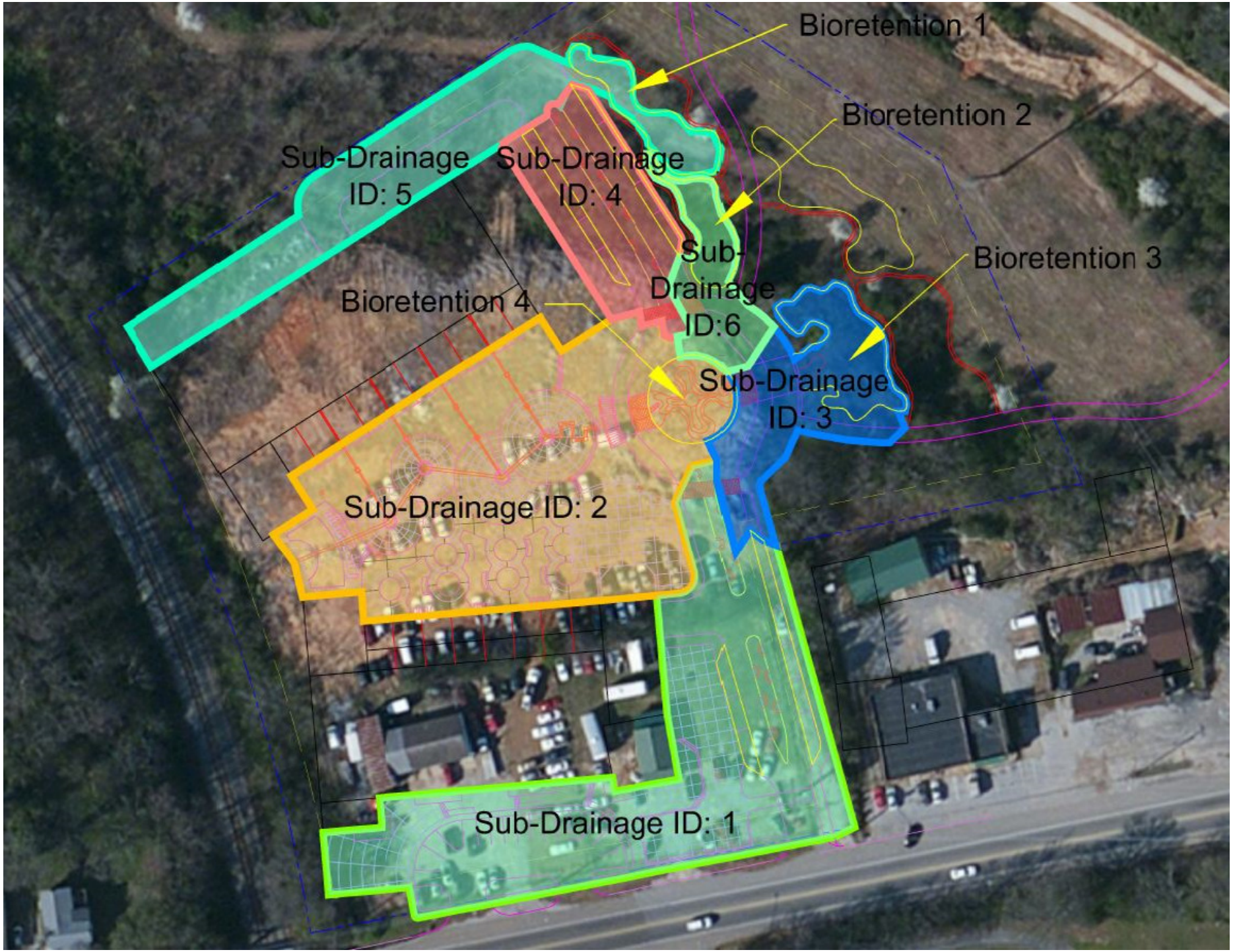
TOOL 3 - BMP SIZING TOOL

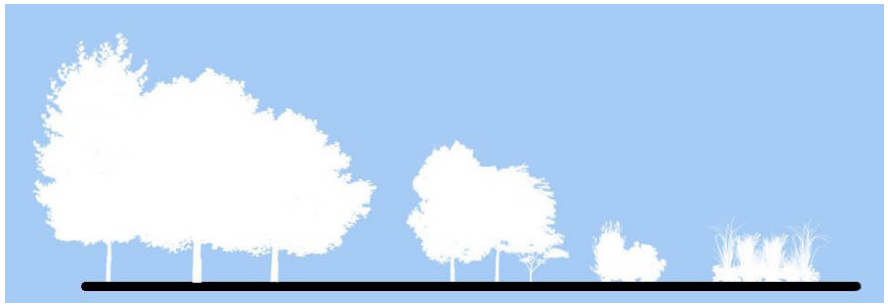
Project Name: BONNY OAKS
Date Prepared: 6/20/2014
Prepared by: 12361

WORKSHEET 4: CN Adjustment

=> Denotes input by user

Point of Interest	Area (ft^2)	Weighted CN	Storm Frequency	Rainfall (in)	S	Q (in)	BMP Capture Volume (ft^3)	Infiltration Volume (ft^3)	Total BMP Volume Reduction (ft^3)	Q minus Total Volume Reduction (in)	Adjusted CN
1	311,454	82.00	10	5.10	2.20	3.17	12,803	12,610	25413	2.19	71
			25	6.00		3.99				3.01	72
			100	7.40		5.29				4.31	73
			10		0.00	0.00			0	0.00	100
			25			0.00				0.00	100
			100			0.00				0.00	100
			10		0.00	0.00			0	0.00	100
			25			0.00				0.00	100
			100			0.00				0.00	100
			10		0.00	0.00			0	0.00	100
			25			0.00				0.00	100
			100			0.00				0.00	100


Bioretention 1
Bioretention 2
Bioretention 3
Bioretention 4
Sub-Drainage ID: 5
Sub-Drainage ID: 4
Sub-Drainage ID:6
Sub-Drainage ID: 3
Sub-Drainage ID: 2
Sub-Drainage ID: 1



Bonny Oaks Development – Proposed Plant Palette

• The plant palette for Bonnie Oaks Development is derived from predominantly native and drought tolerant species. This promotes lower landscape maintenance requirements and conserves water through efficient use of irrigation

• Placing the right plant in the right place relative to soil, water and sunlight creates sustainable landscape patterns.

• The landscape style at Bonny oaks is naturalistic. This ties into the character of the surrounding greenway and South Chickamauga Creek ecosystem

Canopy Street Trees and Plaza Trees:

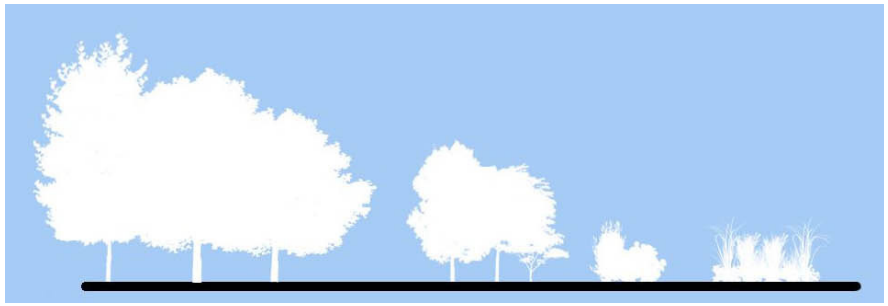
Carpanus betulus 'Fastigiata' - Pyramidal European Hornbeam
Ginko biloba – Ginko Tree
Liriodendron tulipifera - Tulip Poplar
Quercus Nattalli – Nuttall Oak
Ulmus parvifolia – Lacebark Elm

Rain Garden / Bioretention Trees

Acer Rubrum "Summer Red" - Red Maple
Salix Nigra - Black Willow
Taxodium distichum - Bald Cypress
Nyssa sylvatica - Black Tupelo

Understory Trees at Woods Edge:

Cercis Canadensis - Redbud
Cornus Florida - Southern Dogwood
Crataegus viridis 'Winter King - Hawthorne



Bonny Oaks – Proposed Plant Palette
Native and Drought tolerant Plants for Traffic Circle and Meadow Restoration

<u>Shrubs and evergreen:</u>
Ilex vomitoria "Nana"- Dwarf Yaupon Holly
Itea virginica 'Little Henry' - Dwarf Virginia Sweetspire
Juniperus horizontalis 'Plumosa Compacta' - Andorra Juniper
Rhus aromatica 'Gro-Low'- Fragrant Sumac
Spiraea x bumalda 'Limemound' - Limemound Spirea

<u>Rain Garden / Shrubs/ Perennials</u>
Ilex Glabra 'Shamrock' – Shamrock Inkberry Holly
Ilex verticillata 'Red Sprite' - Red Sprite Winterberry Holly
Iris virginica - Southern Blue Flag Iris
Hemerocallis species - Pardon Me Daylily
Panicum virgatum 'Northwind' - Northwind Switchgrass

<u>Perennials and Ornamental Grasses</u>
Artemisia species - Silver Mound
Chasmanthium latifolium - River Oats
Coreopsis verticillata - Moonbeam Coreopsis
Echinacea purpurea - Purple coneflower
Panicum virgatum 'Heavy Metal' - Heavy Metal Switchgrass
Rosmarinus officinalis 'Tuscan Blue' - Rosemary
Rudbeckia fulgida var. fulgida - Black-eyed Susan