City of Chattanooga
Waste Resources Division
Consent Decree Program
Program Management

Transmittal

Date:	3-18-15	**From:**	Mike Marino, P.E.
Attention:	Mary Helms	**Project:**	Consent Decree Program Management
Firm Name:	Chattanooga Public Library	**Project No.:**	C6A02301
Copies to:	CD Public Website	**File:**	

The following document is attached under a separate cover for submittal to the Public Document Repository.

1. Green Infrastructure Program Plan for CSS Basins

Enclosures/Attachments

- ☐ Letter
- ☐ Contract Documents
- ☐ Sketch
- ☐ Modification Drawings
- ☐ Other _____
- ☐ Sample
- ☐ Clarification Drawings
- ☐ Print
- ☐ Shop Drawings

Action Requested

- ☐ Resubmit
- ☐ For Your Review
- ☐ Information Only
- ☐ Your Information and File
- ☐ Please Comment
- ☐ Other _____
- ☐ For Your Approval
- ☐ Reply ASAP
- ☐ For Your Signature

4510 Turntable Road, Suite 110, Chattanooga, Tennessee 37421 USA1.423.799.3075 Fax 1.423.779.3078

JACOBS

City of Chattanooga

Mayor Andy Berke

March 18, 2015

VIA HAND DELIVERY

Ms. Corinne Hill
Library Director
Chattanooga-Hamilton County Public Library
1001 Broad Street
Chattanooga, TN 37402

Subject: ***United States of America et. al. v. City of Chattanooga, No. 1:12-cv-00245***
Consent Decree Public Document Repository
Green Infrastructure Program Plan for CSS Basins

Dear Ms. Hill:

On behalf of the City of Chattanooga, Tennessee ("City"), and in accordance with the Consent Decree entered by the United States District Court for the Eastern District of Tennessee (Southern Division), on April 24, 2013, in the case styled the *United States of America et. al. v. City of Chattanooga, No. 1:12-cv-00245* ("Consent Decree"), we are providing the Chattanooga-Hamilton County Public Library with the Green Infrastructure ("GI") Program Plan for Combined Sewer System ("CSS") Basins ("GI Plan") for submission to the City's Public Document Repository ("PDR").

The purpose of the GI Plan is to:

- Identify specific GI control measures that store, infiltrate, or evapotranspirate precipitation and reduce wet weather flows into the CSS. The GI Plan shall also identify maintenance requirements for the control measures identified;
- Include the development of a Comprehensive Land Use Plan for land owned by the City that assesses the potential for the City, either on its own or in partnership with private parties or other governmental agencies, to implement GI on property owned or operated by Chattanooga;
- Establish and describe a public participation process that provides information about GI; and
- Include a process for setting GI control measure priorities and expeditious implementation schedules.

We are providing a copy of the GI Plan to the PDR for public review and comment, prior to final submission of the GI Plan to the EPA and the State of Tennessee. Thus, we ask that you make this document available to the public for review for thirty (30) days. The public can provide comments to the City by sending comments to the following address:

City of Chattanooga: Waste Resources Division
RE: Consent Decree Public Comments
c/o Jacobs Engineering Group
4510 Turntable Road, Suite 110
Chattanooga, TN 37421

An electronic copy of this document is also available for review and comment on the City's Consent Decree website at the following location:

http://www.chattanooga.gov/public-works/waste-resources/consent-decree/44-public-works/1050-consent-decree-document-repository

We look forward to receiving comments from the public on this important document.

Sincerely,

Michael C. Patrick, P.E.
Director, Waste Resources Division

Enclosure

cc: Donald L. Norris, City of Chattanooga, Public Works Administrator
Mike Marino, PE, Jacobs Engineering Group
Adam Sowatzka, King & Spalding

Green Infrastructure Program Plan

Prepared for

United States Environmental Protection Agency and Tennessee Department of Environment and Conservation

City of Chattanooga
Waste Resources Division
Consent Decree Program
Case No. 1:12-cv-00245

Prepared by

Lamar Dunn & Associates
Gresham, Smith and Partners

Submitted by

Jacobs Engineering Group Inc.
Consent Decree Program Manager

Chattanooga, Tennessee

3/18/2015

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Acronyms and Abbreviations

ac	Acre
CD	Consent Decree, United States of American et. al v. City of Chattanooga, No. 1:12-cv-00245
CDOT	Chattanooga Department of Transportation
CSRB	Chattanooga Stormwater Regulations Board
CHA	Chattanooga Housing Authority
CHZC	Chattanooga Historic Zoning Commission
CLUP	Comprehensive Land Use Plan
CN	Curve Number
CSO	Combined Sewer Overflow
CSOTF	Combined Sewer Overflow Treatment Facility
CSS	Combined Sewer System
DIY	Do-it-Yourself
DNA	Division of Natural Areas
ECD	Economic and Community Development
EPA	United States Environmental Protection Agency
ft	Foot, or Feet
gal	Gallon
GI	Green Infrastructure
GIC	Green Infrastructure Committee
GIS	Geographic Information System
GSA	General Services Administration
HCDE	Hamilton County Department of Education
HSG	Hydrologic Soil Group
ISS	Interceptor Sewer System
LDO	Land Development Office
LID	Low Impact Development
MG	Million Gallons

MOU	Memorandum of Understanding
NPDES	National Pollutant Discharge Elimination System
RMG	Rainwater Management Guide
ROW	Right-of-Way
RPA	Chattanooga-Hamilton County Regional Planning Agency
SOV	Stay on Volume
SSO	Sanitary Sewer Overflow
TDEC	Tennessee Department of Environment and Conservation
TR-55	Technical Release 55
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Services
UTC	University of Tennessee Chattanooga
WCTS	Wastewater Collection and Transmission System
WDPA	World Database on Protected Areas
WQP	Water Quality Program
WRD	Waste Resources Division
WWTP	Wastewater Treatment Plant

Definitions

Absorption: The entrance of water into the soil or rocks by all natural processes. Absorption includes the infiltration of precipitation or snowmelt, gravity flow of streams into the streambed, and the movement of atmospheric moisture.

Anthropogenic: Resulting from the influence of human beings on nature.

Brownfield: As defined by the Tennessee Department of Environment and Conservation (TDEC), real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

Chattanooga (City): The City of Chattanooga, Tennessee, including all of its departments, agencies, instrumentalities such as the Public Works Department, and any successor thereto.

Combined Sewer Overflow (CSO): Any discharge from the Combined Sewer System (CSS) from any outfalls currently identified, or identified in the future, as a permitted combined sewer overflow outfall in any Chattanooga National Pollutant Discharge Elimination System (NPDES) permit from which CSOs are discharged to waters of the United States or the State.

CSS Full Fixture Method: Applicable to projects in CSS areas disturbing more than an acre that propose a net increase to impervious surface. Same as the CSS Simple Fixture Method, except there is no ceiling to the amount of off-line attenuation storage required. The volume of above or underground attenuation storage is governed by applicable calculations. The developer has the option of choosing the CSS primary method.

CSS Primary Method: Same as applicable simple or full fixture methods except any Stay on Volume (SOV) voluntarily incorporated into the primary site, above the 0.5'' minimum baseline for new and significant redevelopments, can result in fee discounts and earned SOV coupons for overdesign upon application, approval and acceptance of As Built Plans. Regardless of whether SOV is partially or fully implemented, the site must meet the same peak attenuation goals as the applicable fixture method.

CSS Simple Fixture Method: Applicable to projects in CSS areas disturbing between 5,000 square feet and one acre or larger projects proposing no net increase to impervious surface; Q_2 through Q_{25} attenuation is required such that proposed development peak discharges (fixtures+ storm) are less than or equal to the recent* existing development peak discharges. The maximum off-line storage required is 25,000 gallons regardless of attenuation calculations. The developer has the option of choosing the CSO primary method. *[Recent* - To adhere to the City's long term CSO Plan and the basis of design for CSO treatment facilities, peak fixture discharges from uses existing prior to year 2000, and since abandoned, are assumed to be zero in calculations. For developments in use after 2000, attenuation design calculations can assume the actual, permitted peak fixture discharges when computing attenuation.]*

Combined Sewer Overflow Outfall: The outfalls currently identified, or identified in the future, as a permitted combined sewer overflow outfall in any Chattanooga NPDES permit from which CSOs are discharged to waters of the United States or the State.

Combined Sewer Overflow Treatment Facility (CSOTF): These are permitted primary treatment facilities in the City's CSS that treat combined stormwater and sanitary sewage and discharge through the CSOTF Outfalls during heavy wet weather events.

Combined Sewer System (CSS): The portion of Chattanooga's Wastewater Collection and Transmission System (WCTS) designed to convey municipal sewage (domestic, commercial and industrial wastewaters) and stormwater runoff through a single-pipe system to Chattanooga's Wastewater Treatment Plant (WWTP) or CSO Outfalls.

Credit Coupon: A coupon issued by the City of Chattanooga to approved applicants for exceeding the SOV requirement on new and redevelopments, retrofit or offsite mitigation sites. With certain restrictions, it can be applied to meet the onsite SOV requirement of another site or be traded or sold in an open market. Credit coupons are given in cubic feet and have no monetary face value.

CSS Discharge Calculator: The City of Chattanooga Public Works Department created a CSS calculator that determines the combined fixture plus stormwater discharge increase for various storm events. These peak discharges can be used to size onsite conveyances, stormwater detention practices and to determine the volume reduction impact that green infrastructure has on attenuation storage.

Curve Number (CN): A hydrologic parameter used to describe the stormwater runoff potential for drainage area. The curve number is a function of land use, soil type, and soil moisture.

EPA: The United States Environmental Protection Agency and any of its successor departments or agencies.

Force Main: Any pipe that receives and conveys, under pressure, wastewater from the discharge side of a pump station. A force main is intended to convey wastewater under pressure.

Gravity Sewer: A pipe that receives, contains and conveys wastewater not normally under pressure, but is intended to flow unassisted under the influence of gravity.

Green Infrastructure (GI): The range of stormwater control measures that use plant/soil systems, permeable pavement, stormwater harvest and reuse, or native landscaping to store, infiltrate, and/or evapotranspirate stormwater.

Impaired Waters: Any segment of surface waters that has been identified by TDEC as failing to support classified uses. TDEC periodically compiles a list of such waters known as the 303(d) List.

Impervious: Not allowing the passage of water through the surface of the ground or ground covering or a substantial reduction in the capacity for water to pass through the surface of the ground or ground covering.

Impervious Surface: This cover type includes any surface that intercepts precipitation and does not allow water to infiltrate. This cover type typically includes hard/paved surfaces (roads, buildings, parking lots, driveways, sidewalks, roofs, and decks).

Infiltration: A complex process of allowing runoff to penetrate the ground surface and flow through the upper soil surface. Water infiltrating during a rainfall event is removed from the direct runoff and usually does not contribute to a stream or other tributary's peak flood flow rate.

Interflow: The lateral movement of water through soils that first returns to the surface or enters a stream prior to becoming groundwater.

Karst: A type of topography that is formed over limestone, dolomite or gypsum by solution of the rock and is characterized by closed depressions or sinkholes, caves and underground drainage.

Low Impact Development (LID): A stormwater management and design strategy that is integrated into design of the development. LID developments strive to conserve natural features, minimize or eliminate pollutants in stormwater through natural processes, and maintain pre-development hydrologic characteristics such as natural flow patterns, surface retention, non-erosive discharge rates and recharge rates.

New Development: Construction of a new building or structure on its own lot is considered new development. New buildings or structures constructed on a lot that already contains existing buildings is considered an expansion.

Pervious Surface: Natural or engineered surface, material, or ground cover that allows for the passage of water into underlying soil layers or media for the purpose of stormwater volume reduction and/or water quality treatment.

Polychlorinated Biphenyls (PCBs): Toxic substances that are a hazard to human health and the environment. Polychlorinated biphenyls were used as dielectric fluid in various types of electrical equipment including heat transfer systems, fluorescent lamp ballasts, television sets, and numerous other kinds of electrical appliances. In addition, PCBs were used as plasticizers in paints, plastics and rubber products, in pigments, dyes, carbonless copy paper and many other applications.

Public Document Repository: The Downtown Branch of the Chattanooga City Library, located at 1001 Broad Street, Chattanooga, TN 37402, and such repository that Chattanooga shall make available via the internet, including through its website, www.chattanooga.gov.

Public Stormwater Project Fund: An account or fund set aside by the City to collect mitigation fee-in-lieu deposits made by owner/applicants. The account will be a subset of the Water Quality Program's existing capital expenditures account. The revenues generated by the mitigation fees will be deposited and periodically used by the City to partially or wholly fund the design, related land acquisition, construction, installation, permitting and perpetual maintenance of publicly-owned stormwater best management practices. Such facilities would be constructed offsite, in lieu of onsite privately-owned practices that could not be constructed or installed as a result of physical site limitations on the owner/applicant's primary site. Public stormwater project funds may also be used to fund reforestation, riparian restoration or other projects with a direct runoff reduction or water quality benefit at the discretion of the City Engineer. To allow for

sufficient funds, the City may pool fees, collected from multiple sites, and install practices upon collection of sufficient funds to initiate desired projects. Public stormwater projects are deemed by the City of Chattanooga as those that have a public benefit for water resources protection or enhancement, stormwater treatment, and/or ecological restoration, and that may have other community benefits.

Pump Station: Facilities owned or operated by Chattanooga that are comprised of pumps which lift wastewater to a higher hydraulic elevation, including all related electrical, mechanical, and structural systems necessary to the operation of that pump station; provided, however, this definition shall not include any residential grinder pumps.

Redevelopment: The alteration of developed land that result in land disturbance. The term is not intended to include such activities as exterior remodeling, which would not be expected to cause adverse stormwater quality impacts.

Retrofit: Retrofit is the voluntary expansion, modification, or other upgrading of existing stormwater management strategies to increase groundwater recharge, promote stormwater reuse, promote runoff reduction, and/or improve water quality. Approved applicants may earn credit coupons and/or water quality fee discounts, for the property owner, upon exceedance of baseline SOV requirements for approved SOV retrofits to existing sites. Since there is no recognized benefit (fee reduction nor SOV avoidance) from applying credit coupons to voluntary retrofit sites, it is not allowed.

Sanitary Sewer Overflow: Any discharge, of wastewater to waters of the United States or the State from Chattanooga's Sewer System through a point source not permitted in any NPDES permit, as well as any overflow, spill, or release of wastewater to public or private property from the Sewer System that may not reached waters of the United States or the State, including Building Backups.

Sanitary Sewer System (SSS): The portion of Chattanooga's WCTS designed to convey only municipal sewage (domestic, commercial and industrial wastewaters) to Chattanooga's Wastewater Treatment Plant (WWTP).

Sewershed: All portions of Chattanooga's WCTS that are a tributary to a trunk sewer entering the WWTP. Each Sewershed is hydraulically linked and independent of other Sewersheds, unless otherwise noted.

Sewer System: The WCTS and the WWTP.

State: The State of Tennessee including all of its departments, agencies, and instrumentalities, and any successor departments, agencies, and instrumentalities.

Stay on Volume (SOV): The volume of stormwater runoff, measured in cubic feet, that must be captured and managed onsite as required by the City's stormwater regulations with no discharge to surface waters or City storm sewers, as calculated by the methodology set forth in the Rainwater Management Guide

Stormwater: As defined by TDEC, it means stormwater runoff, snowmelt runoff, and surface runoff and drainage.

Stormwater System: All facilities owned or maintained by the City for collecting, detaining, conveying, reusing, infiltrating or treating stormwater from any parcel or place upstream or up gradient of any point of discharge to a river or creek not maintained by the City for conveyance of stormwater or flood control. Stormwater system shall also mean all facilities owned by or maintained by the City for purposes of flood control. (Ord. No. 12294, *§* 2, 10-6-09; Ord. No.12377, *§* 1, 4-20-10)

Technical Release 55 (TR-55): Presents simplified procedures to calculate storm runoff volume, peak rate of discharge, hydrographs, and storage volumes required for floodwater reservoirs. These procedures are applicable in small watersheds, especially urbanizing watersheds, in the United States.

Stormwater Treatment Train: Incorporates the use of multiple GI controls in series for purposes of removing particulates and pollutants while also reducing stormwater runoff volume.

Wastewater Collection and Transmission System (WCTS): The wastewater collection, retention, and transmission systems, including all pipes, force mains, gravity sewer lines, lift stations, pump stations, manholes and appurtenances thereto, owned or operated by Chattanooga that are designed to collect and convey municipal sewage (domestic, commercial and industrial) to Chattanooga's WWTP or CSOs. The WCTS is comprised of the SSS and CSS.

Wastewater Treatment Plant (WWTP): Devices or systems used in the storage, treatment, recycling, and reclamation of municipal wastewater at the Moccasin Bend WWTP located at 455 Moccasin Bend Road, Chattanooga, TN 37405-4403.

Water Quality Fee: A fee assessed to users and contributors of flow to the City's stormwater collection, impounding and transportation system. (Ord. No. 12294, § 2, 10-6-09)

Water Quality Fee Discount: A percent reduction to the annual water quality fee, available to non-residential property owners by application. Discounts are awarded for approved controls and practices resulting in an exceedance of the applicable baseline SOV. Discounts are subject to approval by the City.

Water Table: A saturated zone in the soil.

1.0 Introduction

1.1 Purpose

On April 24, 2013, the City of Chattanooga (City) entered into a Consent Decree (CD) with the United States and the State of Tennessee, in the case styled United States of America et. al v. City of Chattanooga, No. 1:12-cv-00245. The City's Waste Resources Division (WRD) has prepared a Green Infrastructure (GI) Program Plan (GI Plan) for review and approval by the United States Environmental Protection Agency (EPA) and the Tennessee Department of Environment and Conservation (TDEC), as a condition of paragraph 26 of the CD.

The purpose of the GI Plan is to:

- Identify specific GI control measures that store, infiltrate, or evapotranspirate precipitation and reduce wet weather flows into the combined sewer system (CSS). The GI Plan shall also identify maintenance requirements for the control measures identified;
- Include the development of a Comprehensive Land Use Plan (CLUP) for land owned by the City that assesses the potential for the City, either on its own or in partnership with private parties or other governmental agencies, to implement GI on property owned or operated by Chattanooga;
- Establish and describe a public participation process that provides information about GI; and
- Include a process for setting GI control measure priorities and expeditious implementation schedules.

1.2 Background

The City is undertaking the development of an integrated approach to address the wet weather issues within the CSS by meeting the requirements set forth in the CD. This integrated approach can facilitate the implementation of a GI program within the CSS area. GI control measures utilize natural systems, products, and processes to aid in managing water resources and water quality. GI can potentially reduce a portion of the stormwater entering the CSS during rain events by allowing stormwater runoff to soak back into the ground.

1.2.1 Description of the Wastewater Collection and Transmission System

As a regional wastewater utility, the City, a Municipal Corporation, owns, operates, maintains, and manages a network of pipes, manholes, pump stations, force mains, combined sewer overflow treatment facilities (CSOTFs), and associated appurtenances that transport wastewater from homes, businesses, and industries to the Moccasin Bend Wastewater Treatment Plant (WWTP). All of this infrastructure is part of the Wastewater Collection and Transmission System (WCTS), as defined in the CD and herein, and managed by the WRD. The City has historically classified the WRD, WWTP, and WCTS as part of the Interceptor

Sewer System (ISS). With the advent of the CD and recent reorganizations within the City, the term ISS is not recognized by all stakeholders and, therefore, the City will refer to WCTS and WWTP as the infrastructure and WRD as the organization to manage this infrastructure. It is important to note that the City does not claim ownership of private service laterals from the served residential, commercial, and industrial structures to the public main line in the street or right-of-way (ROW), including the connection, and that it is the responsibility of the associated property owner to maintain such laterals.

The City's WCTS currently serves approximately 170,000 people with approximately 61,000 customers within the City including 80 permitted industries. It also provides treatment for eight (8) regional or satellite users comprised of approximately 25,000 customers. The WCTS is composed of:

- 1,263 miles of gravity sewer lines (approximate), including 70 miles of combined sewers;
- 30,000 sewer manholes (approximate);
- 70 sewer pump stations;
- 53 miles of sewer force main (approximate);
- Eight (8) CSOTFs;
- One (1) Combined Sewer Storage Facility;
- 192 (approximate) residential/grinder pumps; and
- One (1) Moccasin Bend WWTP.

An organizational chart for the WRD is provided in Appendix A.

1.2.2 Stormwater Technical Guidance Relating to GI

The Rainwater Management Guide (RMG) was developed by the City to provide a comprehensive tool for developers and design professionals to effectively and efficiently meet required rainwater runoff management standards for new and redevelopment projects. The RMG serves as the technical guidance document for the selection, design, installation, and maintenance of a number of stormwater management practices, including the GI controls identified in this GI Plan.

1.2.3 Examples of Existing GI in the City

The City has already made efforts to implement low impact development (LID) and GI controls to manage stormwater runoff. Some of the significant GI projects to note in downtown Chattanooga are:

- Main Terrain Art Park;
- 17th Street Water Tower;
- Highland Park GI Demonstration Project; and
- Johnson Street Redevelopment Project.

The following is a summary of each of these projects.

Main Terrain Art Park

Main Terrain Art Park, shown in Figure 1-1, located in downtown Chattanooga, demonstrates sustainable stormwater practices while providing a public space for fitness activities and interactive art. The large lawn areas are stormwater infiltration basins with underdrain systems connected to the City's harvested rainwater system. The rain water is collected, filtered, treated, and then used to irrigate the landscape. The project was made possible through a National Endowment of the Arts Grant matched by the Lyndhurst Foundation, the City, and Ross/Fowler Architecture and Landscape Architecture.

Figure 1-1
Main Terrain Art Park

17th Street Water Tower

The 17th Street Water Tower and Water Tower Park, displayed in Figure 1-2, is an example of a GI partnership in the CSS area. All of the water that falls on the roof of the City Convention Center is routed to a large underground cistern that was buried in 13th Street adjacent to the facility during an expansion project. Rainwater goes to the cistern and is pumped to a water tower the City erected on 17th Street. The City can use the water in the tower as a source for irrigating public landscaping that the City has put in place through numerous street improvement projects over the last decade.

Figure 1-2
17th Street Water Tower

Highland Park GI Demonstration Project

Estimated to begin construction in Fall 2015, the Highland Park GI Demonstration project will implement controls on selected streets located in the Highland Park neighborhood of Chattanooga as required by the CD. The goal of this project is to improve water quality in the Dobbs Branch sub-watershed by installing GI controls to improve the quality and reduce the quantity of stormwater runoff. The proposed GI controls include pervious pavement, planter boxes, vegetated swales, and various infiltration practices.

Johnson Street Redevelopment Project

Figure 1-3
Johnson Street Redevelopment Project Pervious Brick Pavers

The Johnson Street Redevelopment Project, recipient of the 2014 Governor's Environmental Stewardship Award for Green Building, included pedestrian and bicycle access, LEED certified buildings, and surrounding GI controls. The City entered into a public-private partnership with adjacent property owners to create a pilot project which models sustainable design in Chattanooga's urban core. The design benefited the immediate neighborhood, the traveling public, and the environment via improved stormwater quality and CSO reduction. Construction included pervious brick pavers, pictured below in Figure 1-3, the Flying Squirrel, and the Crash Pad which is the first LEED Platinum certified hostel. To gage GI lifecycle performance, the City installed monitoring wells throughout the project area to gather short-term and long-term data.

1.3 Goal of GI Plan

The goal of this Plan is to establish a baseline GI program for the City of Chattanooga to implement GI controls as required on designated City-owned properties within the CSS area.

1.4 Scope of GI Plan

The scope of the City's GI Plan consists of the following elements:

1. GI Controls and Strategies;
2. Comprehensive Land Use Plan;
3. Public Participation; and
4. Implementation.

2.0 GI Controls and Strategies

This section will identify the GI controls and strategies used in the GI Plan. The GI controls are the basic building blocks of the GI Plan. The GI strategies are collections of GI controls that are applied to a particular land use or impervious area type. The following subsections discuss the GI controls and strategies applicable to the CSS area.

2.1 Controls

GI controls are the building blocks of a sustainable parcel, neighborhood, and city. GI controls mimic nature through the processes of infiltration, evapotranspiration, and capture and use (rainwater harvesting) to manage stormwater and create healthier urban environments. The GI controls that may be implemented throughout the CSS area are:

- Pervious pavements;
- Infiltration practices;
- Bioretention / rain gardens;
- Vegetated swales;
- Vegetated filter strips;
- Green roofs;
- Rain barrels / cisterns;
- Disconnection of impervious areas;
- Stormwater planters;
- Manufactured devices;
- Naturalized basins; and
- Restorative practices.

These GI controls were selected from the RMG which was developed for the City's Water Quality Program (WQP). The RMG contains detailed information on each GI control including siting, selection, and design. The RMG can be found at the following City website: http://www.chattanooga.gov/public-works/city-engineering-a-water-quality-program/water-quality-program/resource-rain. Refer to the RMG Chapter 8 for inspections and maintenance requirements.

The detailed information contained in the RMG has been summarized into GI control fact sheets (Fact Sheets). The Fact Sheets are included in Appendix B and provide an overview of the design features, advantages and disadvantages, applicability, siting considerations, maintenance, costs, and performance for each GI control. These summaries are provided to

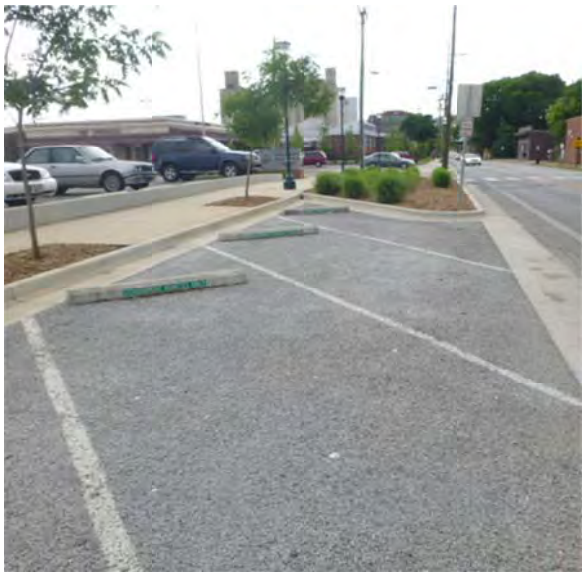
demonstrate what might serve as a handout when soliciting public participation (see Section 4.0).

The following subsections provide general descriptions of each GI control along with a brief discussion of their potential applications.

2.1.1 Pervious Pavement

Pervious pavement, shown in Figure 2-1, consists of a pervious (permeable) surface composed of asphalt, concrete, pavers, reinforced turf, or rubber play surface underlain by an open-graded stone storage or infiltration bed. Stormwater runoff permeates through the surface, is stored within the voids of the infiltration bed, and then slowly infiltrates into the underlying soils.

Figure 2-1
11th Street Police Station Street Parking Pervious Pavement



Pervious pavement areas are well suited for parking lots, playgrounds, plazas, pathways, and other hardscape pavement areas. Stormwater runoff from other portions of the site can be conveyed into an infiltration bed, increasing storage capacity and infiltration. In locations where infiltration is not feasible or is limited, the subsurface infiltration bed can include an underdrain system for slow release. Refer to the RMG Chapter 5.3.1 for additional information including maintenance guidance.

2.1.2 Infiltration Practices

Infiltration practices are a collection of stormwater management techniques in which the entire design capture volume infiltrates to the soil and percolates to shallow aquifers from which it flows to streams as interflow. Water is also removed by plants through evapotranspiration. Additionally, infiltration practices are useful for management of sediment and nutrient loads from stormwater runoff resulting in water quality improvements. Infiltration practices include:

Figure 2-2
Infiltration Trench During and After Installation (RMG Figure 5.3.3-1a and b)

- Infiltration Bed: An infiltration bed captures and temporarily stores stormwater runoff in a media bed that is located beneath an impervious surface or beneath an engineered layer of soil and vegetation. Refer to the RMG Chapter 5.3.2 for additional information including maintenance guidance.

- Infiltration Trench: An infiltration trench, as shown in Figure 2-2, consists of a linear trench of open-graded aggregate or media that can capture, store, and infiltrate stormwater. Its functions are similar to a stormwater infiltration bed except that it may also serve as part of a conveyance system, especially during larger storm events. Refer to the RMG Chapter 5.3.3 for additional information including maintenance guidance.

These GI controls are capable of infiltrating large volumes of stormwater in a very small footprint which can be advantageous for capturing stormwater in urban settings within a CSS. They require minimal maintenance due to the lack of vegetation and soil media. Where sand layers exist below the surface, these GI controls should be considered.

2.1.3 Bioretention / Rain Garden

Bioretention areas, as shown in Figure 2-3, are vegetated, shallow surface depressions that use the interaction of plants, soil, and microorganisms to store and treat stormwater runoff. Small bioretention areas are often referred to as rain gardens. Bioretention areas designed for infiltration purposes can also be referred to as bio infiltration areas, while those that cannot infiltrate and must discharge via an underdrain system are sometimes referred to as biofiltration areas.

Figure 2-3
Renaissance Park Bioretention

Bioretention areas are generally flat and include engineered or modified soils that allow drainage of stormwater through soils. Plants are a critical component of bioretention, and improve the soil structure and porosity through the establishment of root systems and microbial communities. Water that has drained through a bioretention area may infiltrate into the subsoil or discharge at a controlled flow rate through an underdrain system (or a combination of both). Refer to the RMG Chapter 5.3.4 for additional information including maintenance guidance.

2.1.4 Vegetated Swale

A vegetated swale is a landscaped channel, often broad and shallow with trapezoidal or parabolic geometry and a slight longitudinal slope, used to convey and treat stormwater runoff. Vegetated swales are densely planted with grasses, shrubs, and often trees, and can be used to improve water quality and reduce flow rates. Vegetated swales are commonly used in a “stormwater treatment train” approach to protect downstream controls and improve the performance of the treatment train. If the swale includes berms or check dams such that water is retained and allowed to infiltrate, a vegetated swale can provide volume management. Refer to the RMG Chapter 5.3.5 for additional information including maintenance guidance.

2.1.5 Vegetated Filter Strip

Vegetated filter strips are permanent areas of dense vegetation located between runoff pollutant sources (such as parking lots) and other stormwater controls or receiving water bodies. Vegetated filter strips may be constructed of turf, meadow grasses, or other vegetation such as landscape plantings and often attenuate smaller volumes of water due to their adaptable placements in congested urban areas and public work features. Vegetated filter strips can act as pretreatment devices in a “stormwater treatment train” operation which impede the velocity of stormwater runoff (thereby allowing sediment to settle out), reduce the impacts of temperature, and encourage infiltration. Thus, vegetated filter strips can be a useful control to slow the rate of runoff and reduce peak flows. Refer to the RMG Chapter 5.3.6 for additional information including maintenance guidance.

2.1.6 Green Roof

A green roof (also referred to as a vegetated roof or living roof) consists of vegetated roof cover used to mimic the hydrologic performance of surface vegetation rather than the impervious surface cover of a flat or pitched roof. Green roofs, as shown in Figure 2-4, may be designed to meet a variety of goals and conditions including reduction in runoff volume, reduction in runoff flow rate, and improvements in water quality.

Figure 2-4
City Council Building Green Roof

Green roofs may be extensive systems, intensive systems or somewhere in between. Extensive systems are lightweight, lower in cost, and lower in maintenance. Intensive systems are more complex green roof designs which incorporate deeper soils to promote and sustain larger planting structures and integrate human occupancy of roof space.

In addition to stormwater benefits, green roofs can provide direct benefits in terms of increased longevity of the roofing system (by protecting the roof from temperature extremes) and insulation benefits that may reduce heating or air-conditioning energy costs. Refer to the RMG Chapter 5.3.8 for additional information including maintenance guidance.

2.1.7 Rain Barrel / Cistern

Rain barrels/cisterns capture and reuse rainwater. The collected runoff can be used as a resource when it is captured from rooftops and other impervious surfaces. Captured rainwater can be used for landscape irrigation, vehicle washing, street cleaning, and, depending upon local plumbing codes, toilet flushing. Roof runoff is generally cleaner and more suitable than runoff from parking lots and roads, which require additional treatment and maintenance to address sediment, oils and grease. Air-conditioning condensate (although not part of runoff) can

also be captured in cisterns for reuse instead of being discharged to the CSS. Rain barrels/cisterns may reduce the volume and peak flows associated with stormwater runoff in highly urbanized areas where infiltration practices are not feasible. Refer to the RMG Chapter 5.3.9 for runoff capture and reuse, and additional information regarding rain barrels and cisterns.

2.1.8 Disconnect Impervious Area(s)

The disconnection of impervious areas can be achieved by directing runoff from roof downspouts, roads, driveways, and other paved surfaces toward vegetated areas rather than conveying runoff to the CSS. Impervious area disconnections can be a low-cost retrofit, or can reduce piping costs on new construction projects. The GI control can also reduce erosion at the outlets of stormwater drainage systems by dispersing runoff near the source. Refer to the RMG Chapter 5.3.10 for additional information and maintenance guidance.

2.1.9 Stormwater Planter

Stormwater planters are structures, either elevated or at ground level, which are filled with bioretention soils and plants to capture, detain, and filter stormwater runoff through physical, biological, and chemical processes. Planters are commonly constructed of concrete, concrete masonry units, or brick. They can be placed adjacent to the external downspouts of a building to receive rooftop runoff, or along streets to receive runoff from impervious surfaces such as sidewalks or roadways. Planters can be designed as flow-through planters which could direct runoff back into the CSS or infiltration planters which infiltrate stormwater runoff into native soils or an infiltration bed. A few different stormwater planter categories are mentioned below in more detail.

- Stormwater Planter Box: Stormwater planter boxes contain bioretention soils and typically short growth plants with a shallow root system. They may be designed with open bottoms to infiltrate water or with an impervious bottom discharging to the CSS. Temporary surface ponding detains stormwater to allow percolation through the soil media. Refer to the RMG Chapter 5.3.11 for additional information including maintenance guidance.
- Tree Trench: Tree trenches are stormwater planters that require a more substantial structure in order to house a healthy tree and root system. Tree trenches provide additional benefits such as tree canopy and air quality improvements. Refer to the RMG Chapter 5.3.11 for additional information including maintenance guidance.
- Stormwater Curb Extension: Stormwater curb extensions are a specific type of planter that can be incorporated into a streetscape to assist with traffic calming or defining parking areas. Stormwater curb extensions, bump outs, bulb outs and more are variations of stormwater planters. Refer to the RMG Chapter 5.3.11 for additional information including maintenance guidance.

2.1.10 Manufactured Devices

Manufactured devices are pre-fabricated devices that implement technologies ranging from filtration and adsorption to vortex separation and settling to treat stormwater runoff. Treatment

may be necessary downstream of areas where excessive pollutants, such as oil and grease, discharge to a stream, to the CSS, or to other GI controls. Common types of manufactured devices include hydrodynamic devices, catch basin inserts, cartridge filters, and bio treatment devices. Manufactured devices provide stormwater treatment with varying degrees of effectiveness. Refer to the RMG Chapter 5.3.12 for detailed information including maintenance guidance.

2.1.11 Naturalized Basin

A naturalized basin is a shallow, vegetated basin that collects and filters runoff. The hydrology can be designed so that the naturalized basin creates a constructed wetland. The basins allow pollutants to settle out as water infiltrates or is retained in plant material. An outlet structure within the basin is designed to provide peak flow rate control with overflow capacity. A naturalized basin may reduce the runoff volume, provide temperature mitigation, create habitat, and reduce maintenance needs.

Retrofitting an existing traditional detention basin into a naturalized basin can be very cost-effective in developed areas where existing basins only provide large storm peak flow rate mitigation. Refer to the RMG Chapter 5.3.13 for additional information including maintenance guidance.

2.1.12 Restorative Practices

Restorative practices vary widely depending upon the predevelopment conditions of the site and the existing space available for improvements. The goals of restorative practice are to mimic natural functions found in undisturbed watersheds in a way that accommodates runoff from urbanized basins. A few common restorative practices are mentioned below in more detail.

- Recreate Natural Flow Patterns: In many urban and suburban areas, flow paths have been constricted, rerouted, buried, paved, or built over until the original drainage patterns were obscured and the stormwater management benefits have been lost. Natural flow patterns create a dispersed, multi-scale drainage network including conveyance and detention as well as other components. Refer to the RMG Chapter 5.4.1 for additional information.
- Improve Native Landscape Cover Types: The “natural” landscape is an important tool to reduce stormwater runoff volume and velocity and to improve water quality. Remnants of native plant communities found on development sites are frequently degraded, damaged, transformed, or partially destroyed. Restoring the landscape allows natural processes to bring about gradual recovery to an ecosystem.

  Reforestation is an example of improving native landscape cover and is essential to the restoration of many natural habitats. Forested buffers that lie between land and water are an essential part of the ecosystem. Buffer establishment and reforestation aids in park improvement, neighborhood and highway beautification, and the planting of shade trees in parking and pedestrian areas. Refer to the RMG Chapter 5.4.2 for additional information.
- Amend and Restore Disturbed Soils: Healthy soil is a living natural system consisting of a mixture of weathered minerals, decomposing organic matter, and biological organisms that contains adequate air and water for the support of plants. These soils permit water

infiltration for groundwater recharge and provide water-holding capacity to support vegetation, both contributing to reduction in stormwater runoff. Refer to the RMG Chapter 5.4.3 for additional information.

2.1.13 Performance Summary

The effectiveness of each of the applicable GI controls varies for the range of benefits. Table 2-1 was extracted from the RMG and illustrates the relative performance of the GI controls outlined in this GI Plan.

Table 2-1
GI Control Performance

GI Control / Performance	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation	Maintenance Burden	Cost
Pervious Pavement	●	●	●	●	●	◎	○	○	◎
Infiltration Practice	●	●	◎ / ●	●	●	○ / ◎	○	○	◎
Bioretention/ Rain Garden	○ / ◎	●	◎	○ / ◎	●	◎	●	○ / ◎	○ / ◎
Vegetated Swale	●	●	◎	◎	◎	◎	◎	○	○
Vegetated Filter Strip	○	◎	◎	○ / ◎	◎	◎	○	○	○
Green Roof	◎	●	●	○ / ◎	●	●	◎	○ / ◎	◎ / ●
Rain Barrel/ Cistern	●	●	●	○ / ◎	●	○	○	◎ / ●	◎ / ●
Disconnect Impervious Area	●	○	●	●	●	●	○	○	◎
Stormwater Planter	○ / ◎	◎ / ●	◎ / ●	◎	◎ / ●	◎ / ●	○ / ◎	◎ / ●	○ / ◎
Manufactured Device	○ / ◎	○ / ◎	○ / ◎	○ / ◎	○ / ◎	○ / ◎	○ / ◎	○ / ◎	○ / ◎
Naturalized Basin	●	●	●	●	●	●	●	○	○
Restorative Practice	◎ / ●	◎ / ●	●	◎ / ●	◎ / ●	○ / ◎	●	○ / ◎	○ / ◎
Table Key:				○=Low		◎=Medium		●=High	

2.2 Strategies

GI strategies are collections of GI controls that are implemented with certain types of land use or impervious area (parking surfaces, buildings, or streets). The GI strategies identified within the GI Plan are:

- Green housing;
- Green parking;
- Green public facilities and services;
- Green schools;
- Green open spaces;
- Green streets; and
- Green partnerships.

2.2.1 Green Housing

Within the CSS area, housing options range from single-family homes to multifamily public housing. Rooftops and driveways are the impervious areas typically associated with residential land uses. Most housing areas maintain landscaping around the property which would benefit from the use of stormwater harvesting and reuse practices. GI controls preferred for green housing strategies are rain gardens and pervious pavements. Rain barrels or cisterns and disconnection of downspouts are also applicable to the green housing strategy. This strategy would be developed through coordination with the City's Department of Economic and Community Development (ECD) and the Chattanooga Housing Authority (CHA).

2.2.2 Green Parking

Parking lots throughout the CSS area are paved surfaces that often connect directly to the CSS. Applications for GI controls could include pervious pavements and disconnected impervious surfaces. Other GI controls to mitigate runoff in parking areas include infiltration practices such as infiltration beds, bioretention areas, and stormwater planters. Incorporating trees within stormwater planters, vegetated swales, or bioretention areas is recommended for application on surface parking lots as increasing tree canopy is an initiative throughout the City. This strategy would be developed through coordination with the Chattanooga Department of Transportation (CDOT) and the Land Development Office (LDO).

2.2.3 Green Public Facilities and Services

Local government facilities include fire stations, public works facilities, and other land uses providing civic services. Green roofs, rain barrels, cisterns, and impervious area disconnection are examples of GI controls that could be used at these facilities. This strategy could be developed through coordination with the City's General Services Administration (GSA).

2.2.4 Green Schools

GI controls applicable to the CSS area may be suited for implementation on school properties. The University of Tennessee – Chattanooga (UTC) campus provides opportunities for features such as pervious pavement parking, rain gardens, and bioretention swales. Runoff-reducing elements could also be included on campus buildings in the form of green roofs or cisterns. This strategy would be developed through coordination with UTC and Hamilton County Department of Education (HCDE).

2.2.5 Green Open Spaces

Open spaces within the CSS area are primarily City parks and vacant properties. A green open spaces strategy would seek to enhance or create a community amenity. Larger GI controls, such as restorative practices and naturalized basins, can be utilized for the green open spaces strategy to manage stormwater from neighboring properties or neighborhoods. If the economics allow, marginal, distressed, non-tax paying lots could be candidates for restoration and creating greenways, especially along riparian corridors. This strategy would be developed through coordination with the parks division of City Public Works, City ECD, and LDO.

2.2.6 Green Streets

The ROW consisting of streets, alleys, and sidewalks is a source of stormwater runoff within the CSS area. A green streets or complete streets strategy may include several methods to reduce the amount of impervious surfaces along the streetscape. Possible GI controls include stormwater planters with street trees, pervious pavements, bioretention within medians, and disconnected impervious surfaces.

The City of Chattanooga revised the City Code to include Complete Streets (Article XIV) in April 2014. The article, located in Appendix C, requires transportation projects to incorporate sustainable water quality management principles, where applicable, to reduce pollutant, temperature, and runoff impacts to local waterbodies.

Specifically, the ordinance requires the CDOT, Public Works, City ECD, Chattanooga-Hamilton County Regional Planning Agency (RPA), and other relevant departments, agencies, or committees to review and modify current City standards, including but not limited to subdivision regulations, zoning codes and ordinances to ensure that they effectively implement Complete Streets principles. The ordinance also requires such groups to incorporate Complete Streets principles into all future planning documents, manuals, design standards, checklists, decision-trees, rules, regulations, programs, neighborhood redevelopment projects, and other appropriate endeavors.

2.2.7 Green Partnerships

Current City development regulations contained in the City Code, the zoning ordinance, and the RMG contain provisions to reduce stormwater runoff City-wide. These regulations require coordination amongst City Departments in order to implement GI. The use of GI can be encouraged amongst the City's departments through awards, recognition programs, and project grants.

Awards and Recognition Programs - The City has provided marketing opportunities and public outreach through the LID competition organized by the City Engineering and WQP, RPA, the Lyndhurst Foundation, and green|spaces. The competition consisted of design teams composed of architects and engineers competing for up to $10,000 in prizes. Each team selected a predetermined site supplied from the City and performed a design and analysis utilizing the RMG and LID calculation tools recently developed by the City. Over the last year, the City of Chattanooga developed new runoff reduction standards for development and redevelopment sites. The goal of this design challenge was to accelerate the adoption of LID and GI practices as the preferred method of managing stormwater, and complying with the new standards. A similar competition could be established for the City's departments by the Mayor's Office.

Project grants may be obtained from a variety of state or federal sources. Projects, whether retrofit, redevelopment, or new construction could be required to meet stormwater runoff reductions above and beyond the current minimum to receive funding.

The WQP established a Credits & Incentives program to award water quality fee discounts to property owners and credit coupons to approved applicants for overdesigning SOV practices above the baseline. When determining target Stay on Volume (SOV) in the CSS area, the CSS Primary Method may be used by developers to demonstrate management of additional SOV over the 0.5-inch recommended in the CSS area. This allows the developer to be eligible for Water Quality Fee Discounts and Credit Coupons for use on applicable sites or trade on open credit market.

Additionally, property tax reductions may be used to encourage building and site retrofits and new construction that include runoff reduction components. The tax abatement is usually focused on incentivizing a specific control or a short list of controls in a given basin where the controls are documented to provide solutions to volume, water quality, or other problems.

2.3 GI Strategy Summary

Each of the GI strategies can be associated with the most applicable GI controls. In general, the amount of available space and types of impervious areas dictate the applicable GI control determination. In addition, GI strategies for retrofit may be more limited than GI strategies for new development. The applicable GI controls for the various GI strategies are shown in Table 2-2.

Table 2-2
GI Controls and GI Strategies Matrix

GI Control \ GI Strategy	Green Housing	Green Parking	Green Public Facilities and Services	Green Schools	Green Open Spaces	Green Streets	Green Partnerships
Pervious Pavement	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●
Infiltration Practice	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●
Bioretention/Rain Garden	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●
Vegetated Swale	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●
Vegetated Filter Strip	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●
Green Roof	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●
Rain Barrel/Cistern	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●
Disconnect Impervious Area	⊙	⊙	⊙	⊙	⊙	⊙ / ●	⊙
Stormwater Planter	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●
Manufactured Device	○	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●
Naturalized Basin	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●
Restorative Practice	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●	⊙ / ●

Table Key: ○=Not Applicable ●=New/Redevelopment ⊙=Retrofit ⊙ / ●=Limited Applications

3.0 Comprehensive Land Use Plan

This GI Plan includes the development of a Comprehensive Land Use Plan (CLUP) that assesses the potential for Chattanooga, either on its own or in partnership with private parties or other governmental agencies, to implement GI on property owned or operated by the City. The CLUP contains:

- A comprehensive land use analysis;
- An assessment of GI implementation potential;
- A project area identification process;
- A project rating system for setting GI priorities; and
- A demonstration of the process with GI project area concepts.

The goal of the CLUP is to equip the City with a comprehensive land use analysis and a process that demonstrates how the results of the analysis may be used to identify and prioritize potential GI project areas.

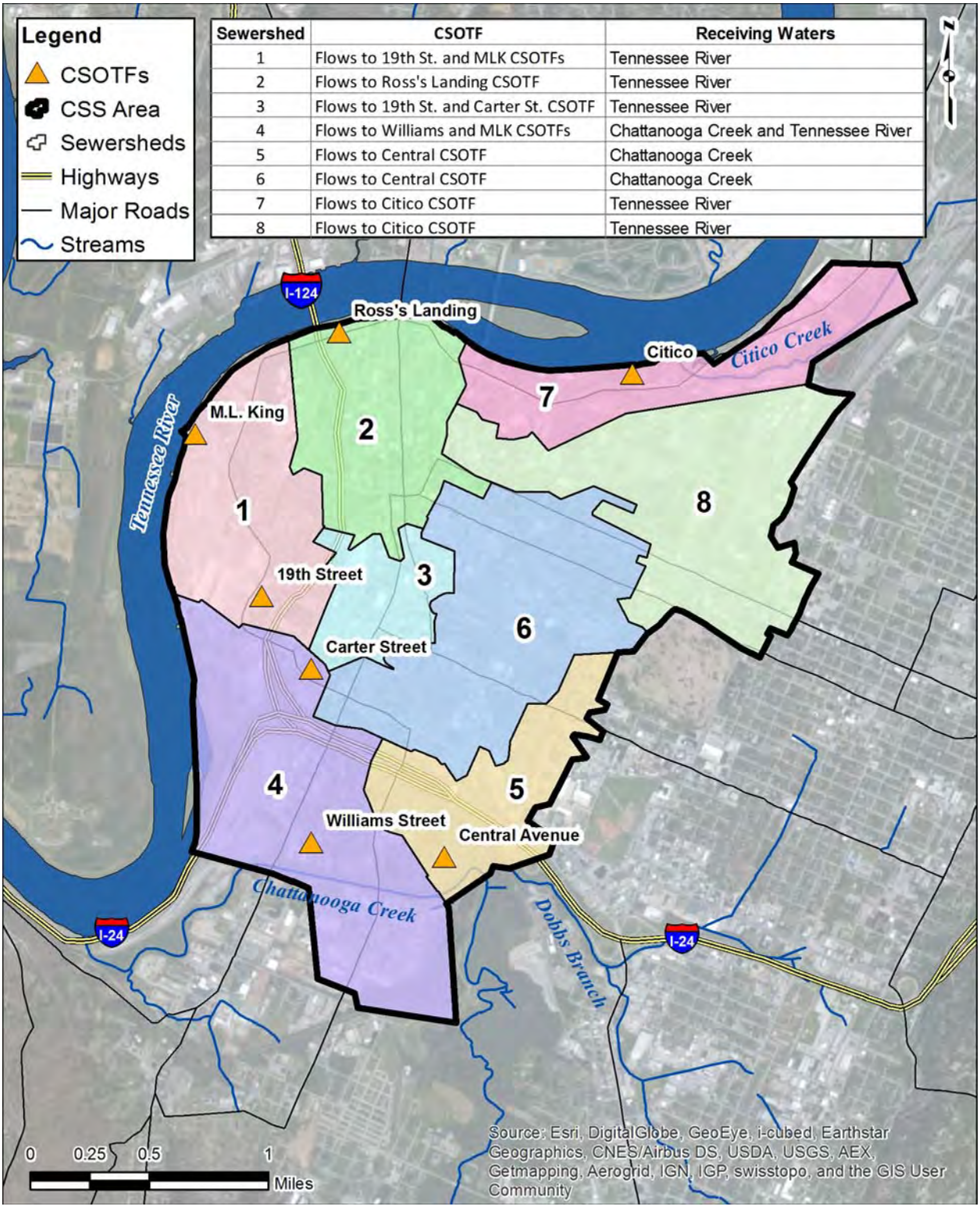
3.1 Comprehensive Land Use Analysis

The CSS area is defined in this GI Plan by eight (8) sewersheds which contribute combined flows to seven (7) of the City's total of eight (8) CSOTFs. The CSS area covers approximately 3,352 acres, which includes downtown Chattanooga. The boundaries of the CSS area and the CSOTFs are illustrated in Figure 3-1. This delineation provides the boundary for the comprehensive land use analysis.

The comprehensive land use analysis was performed to determine:

- Ownership of property within the CSS area;
- Composition of land use within the CSS area; and
- Imperviousness of property within the CSS area.

Figure 3-1
Combined Sewer System Area



3.1.1 Property Ownership

The CSS area is approximately 3,352 acres and consists of 3,035 parcels which cover 2,345 acres. The remaining 1,007 acres of land between parcels is the ROW. Parcels and ROW have been analyzed to determine the magnitude of City ownership in the CSS area.

For the analysis, ownership of properties within the CSS area were divided into City-owned, publicly-owned, and privately-owned categories. The ownership of the properties was determined based on the Hamilton County (County) Government Data Processing standard Property Type (see Appendix D). Parcel data from the County was provided on February 22, 2013. Land use classes were assigned using the County Data Processing standard.

Using the parcels data provided by the County, City-owned properties were defined using Code 02: City-owned. Publicly-owned properties included the Property Types in Table 3-1. The remaining properties not City-owned or publicly-owned were defined as privately-owned properties. The parcel ownership statistics are shown in Figure 3-2.

Table 3-1
Publicly-Owned Parcel Designation

Code	Description
01	County-Owned
03	State-Owned
04	Federally-Owned
07	Utility and Public Service
11	Chattanooga Housing Authority
13	Hospital Authority
14	County Schools
15	City Schools
21	Community Lot
35	County/City
37	None[a]
98	In Lieu of & Deferred Taxes

[a] Code 37 was not defined as part of the Hamilton County Government Data Processing standard table provided. Review of specific ownership reflected City of Chattanooga and Electric Power Board as co-ownership. Since ownership is not solely owned and operated by the City, this Property Type has been included in publicly-owned parcels.

The ROW was delineated in a geographic information system (GIS) using the County parcel data to divide street ROW from railroad ROW. The street ROW was further analyzed to in order to delineate City ROW from public ROW (state and federal ROW). The ROW ownership statistics are shown in Figure 3-3.

Figure 3-2
Parcel Ownership in the CSS Area in Acres

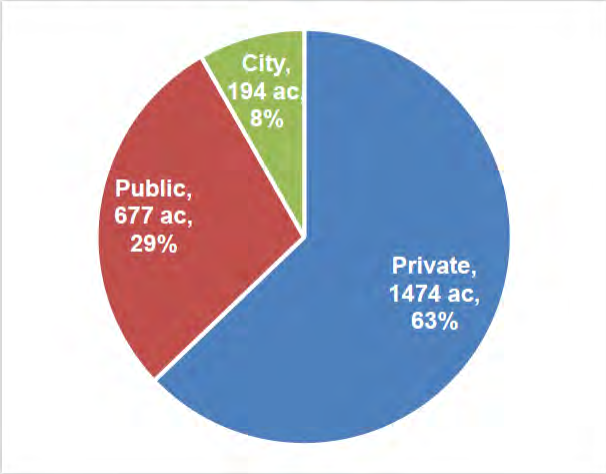
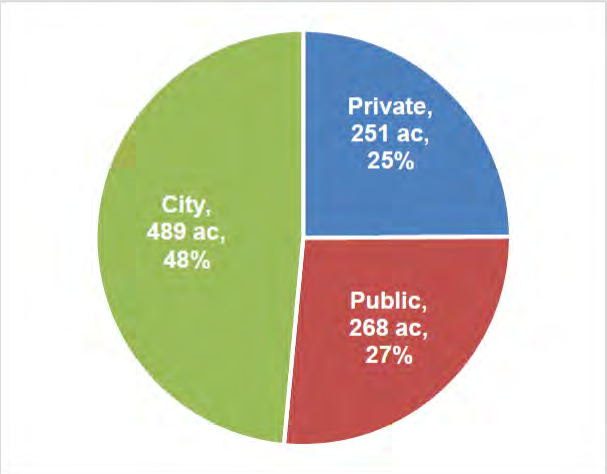


Figure 3-3
ROW Ownership in the CSS Area in Acres



Of the parcels within the CSS area, 123 properties are owned by the City covering 194 acres (8% of the CSS area). Additionally, the ownership statistics revealed that there are 311 properties which cover 677 acres publicly-owned by other governmental organizations. The City owns and operates nearly half (489 acres, 48%) of the ROW in the CSS area. The public (state and federal government) and private (railroad) ROW make up the remaining 52% with areas of 268 acres and 251 acres, respectively.

Based on the findings of the property ownership determination, the CLUP shall apply to the 682 acres (approximate) of properties (parcels and ROW) exclusively owned and operated by the City.

3.1.2 Land Use Composition

Land use considers the current and future use of land throughout the City. The parcel data supplied by the County contained designated Land Use Types as defined in the County Data Processing standards (see Appendix D).

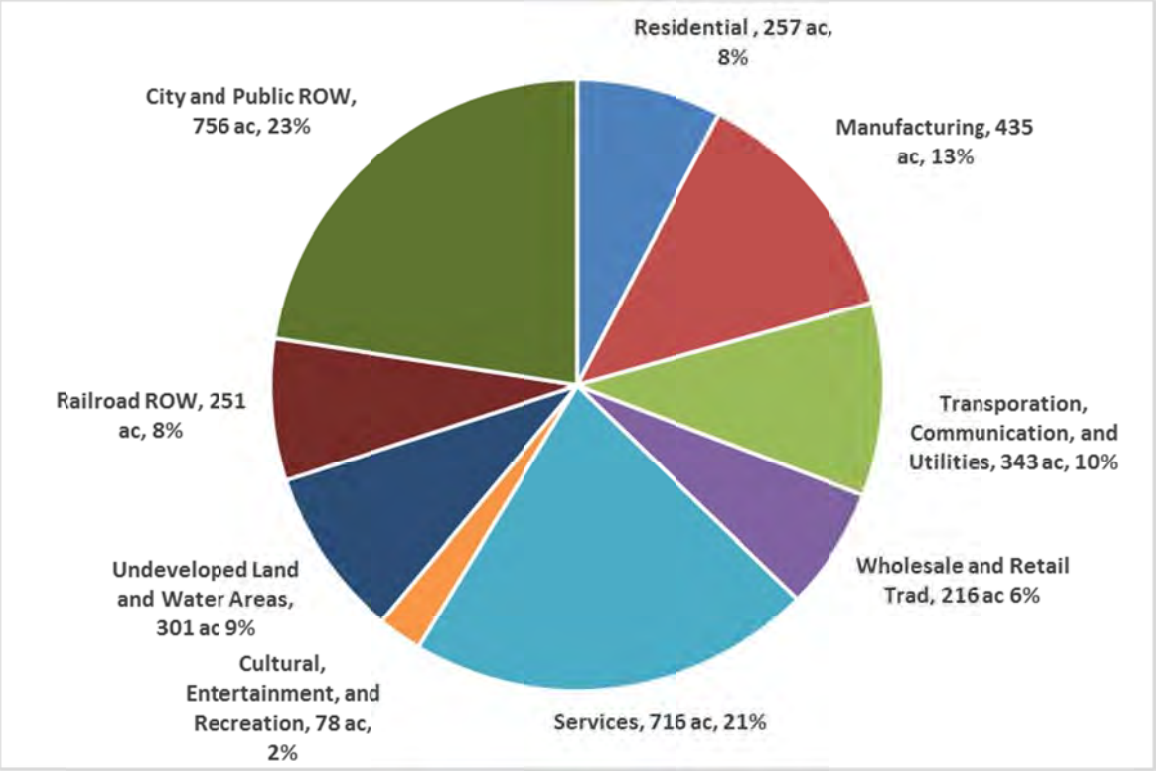
There are eight (8) primary land use categories designated by the Hamilton County standard land use codes:

- Residential;
- Manufacturing;
- Transportation, communication, and utilities;
- Wholesale and retail trade (Commercial);
- Services;

- Cultural, entertainment, and recreational;
- Resource production and extractions; and
- Undeveloped land and water areas.

The land use composition data is shown in Figure 3-4. Parcels with designated land uses comprise 2,345 acres of the CSS area. The remaining areas were designated as railroad and ROW resulting in 251 acres and 756 acres, respectively. The only land use category not represented within the CSS area is resource production and extractions.

Figure 3-4
Land Use Composition of All Properties in the CSS Area in Acres



The individual land use codes were divided to provide more granularity than the general land use categories provided. This allowed land use to support the alignment of land use with the GI strategies outlined in Section 2.2. The alignment of land use and GI strategies is located in Appendix E. The land use subcategories were defined according to Table 3-2.

Table 3-2
Land Use Subcategory and Code Ranges

Land Use Category	Land Use Subcategory	Land Use Code Range
Residential	Residential	100-150
Manufacturing	Manufacturing (Industrial)	200-397
Transportation, Communication, and Utilities	Transportation and Parking	410-469
	Communications, Utilities, and Warehouse	470-495
Wholesale and Retail Trade	Wholesale and Retail Trade (Commercial)	500-590
Services	General Services	600-676, 693-694
	Hospitals	650, 653-654
	Schools	680-687
	Churches and Charities	690-695
Cultural, Entertainment, and Recreational	Recreation	700-750
	Parks	760
Resource Production and Extractions	Resource Production and Extractions	800-850
Undeveloped and Unused Land	Undeveloped and Unused Land	0, 900-970
Railroad ROW	Railroad ROW	None[a]
City and Public ROW	City and Public ROW	None[a]

[a] Land use code ranges apply to parcels which do not include City, public, or railroad ROW.

The City-owned land area available for each GI strategy and land use subcategory are shown in Table 3-3. The opportunities based on land area of City-owned properties within the CSS area for GI implementation are:

- City ROW as Green Streets;
- General services (includes governmental functions and services such as police, fire, and maintenance yards) as Green Public Facilities and Services; and
- Parks and Vacant and Unused Lands as Green Open Spaces.

Table 3-3
GI Strategy and Land Use Subcategory Composition of City-owned Property in the CSS Area

GI Strategy	Land Use Subcategory	City-owned	
		# of Parcels	Area (acres)
Green Housing	Residential	3	0.59
Green Parking	Transportation and Parking	6	2.70
Green Public Facilities and Services	Communications, Utilities, and Warehouse	2	0.71
	General Services	52	58.49
	Hospitals	-	-
	Recreation	5	8.39
Green Schools	Schools	1	1.30
Green Open Spaces	Parks	6	49.61
	Undeveloped and Unused Land	40	53.06
Green Partnerships	Manufacturing (Industrial)	3	10.84
	Wholesale and Retail Trade (Commercial)	5	8.31
	Churches and Charities	-	-
	Railroad ROW	-	-
Sub Totals		**123**	**194.00**
Green Streets	City and Public ROW	-	488.70
Totals		**123**	**682.70**

3.1.3 Imperviousness

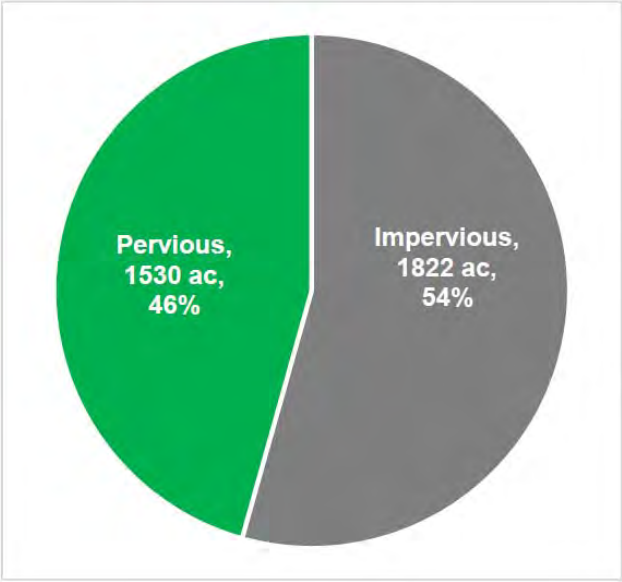
The negative impacts of stormwater runoff can be correlated to increased amounts of impervious cover, therefore understanding imperviousness of the CSS area sets a baseline for the assessment of GI potential.

The land use types and ownerships of each parcel were analyzed for impervious surfaces. A geographic information system (GIS) analysis was performed in order to determine the impervious coverage for each parcel and ROW. The City-supplied impervious data is a conglomeration of all impervious surfaces used for determining Water Quality Fees throughout the City.

The impervious surface data were used along with the County parcel data and delineated ROW to perform the impervious analysis. The County parcels data and delineated ROW within the CSS area were intersected with the impervious data to assign impervious areas to the parcels and ROW.

The CSS area properties and the ROW consist of 1,822 total impervious acres, approximately 54% of the total CSS area as shown in Figure 3-5.

Figure 3-5
Total Imperviousness in the CSS Area in Acres



The imperviousness of each GI strategy and land use subcategory was determined for the City-owned properties within the CSS area to identify opportunities for GI implementation and assess GI potential. Table 3-4 summarizes the City-owned land uses within the CSS area and the impervious cover that each contributes.

Land use with high impervious percentages are opportunities where GI may have a significant positive impact on reducing runoff. As shown in Table 3-4, the City-owned land use subcategories with high imperviousness are wholesale and retail trade and transportation and parking. These land uses are 95% impervious and 87% impervious respectively.

The City-owned land use subcategories with low imperviousness present opportunities for regional GI controls. City undeveloped and unused land are 20% impervious and parks which are 40% impervious. Therefore, Green Open Spaces strategies may present the best opportunity for regional GI controls which can be used to manage stormwater runoff from adjacent parcels or upstream ROW.

Table 3-4
GI Strategy and Land Use Subcategory Imperviousness of City-owned Property in the CSS Area

GI Strategy	Land Use Subcategory	City-owned	
		Impervious Area (acres)	Percent Impervious (%)
Green Housing	Residential	0.00	0%
Green Parking	Transportation and Parking	2.34	87%
Green Public Facilities and Services	Communications, Utilities, and Warehouse	0.38	53%
	General Services	22.53	39%
	Hospitals	-	-
	Recreation	4.57	54%
Green Schools	Schools	0.93	72%
Green Open Spaces	Parks	19.93	40%
	Undeveloped and Unused Land	10.52	20%
Green Partnerships	Manufacturing (Industrial)	6.83	63%
	Wholesale and Retail Trade (Commercial)	7.86	95%
	Churches and Charities	-	-
	Railroad ROW	-	-
Sub Totals		**75.89**	**39%**
Green Streets	City and Public ROW[a]	264.43	54%
Totals		**340.32**	**50%**

[a] City and Public ROW imperviousness statistics were derived from City impervious data. Normal ROW impervious values are typically higher than those tabulated here.

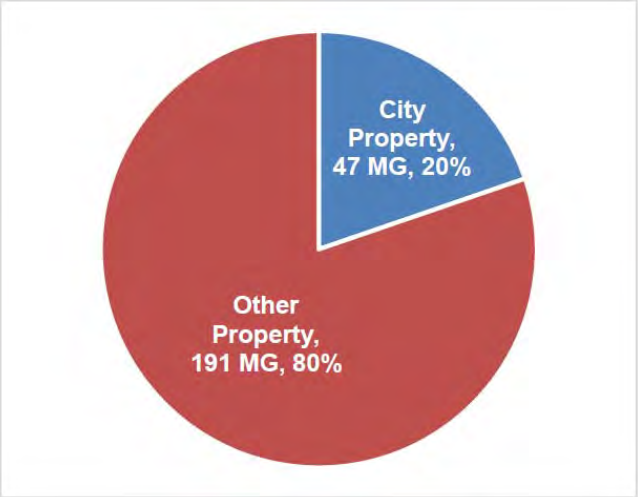
3.2 Assessment of GI Potential

An assessment of the GI potential was conducted to demonstrate the impact of implementing GI on City-owned property within the CSS area. The assessment may also assist in setting feasible goals related to GI performance by illustrating a comparison of varied GI implementation levels. The results from the comprehensive land use analysis in Section 3.1 were used to conduct the assessment. The methodology, inputs, and outputs for the assessment are documented in Appendix F.

The assessment of GI potential included analyses of six (6) different scenarios:

- One (1) baseline scenario;
- Four (4) generic scenarios; and
- One (1) target demonstration scenario.

Figure 3-6
Runoff from 2-Year, 24-Hour Rainfall in CSS Area in MG

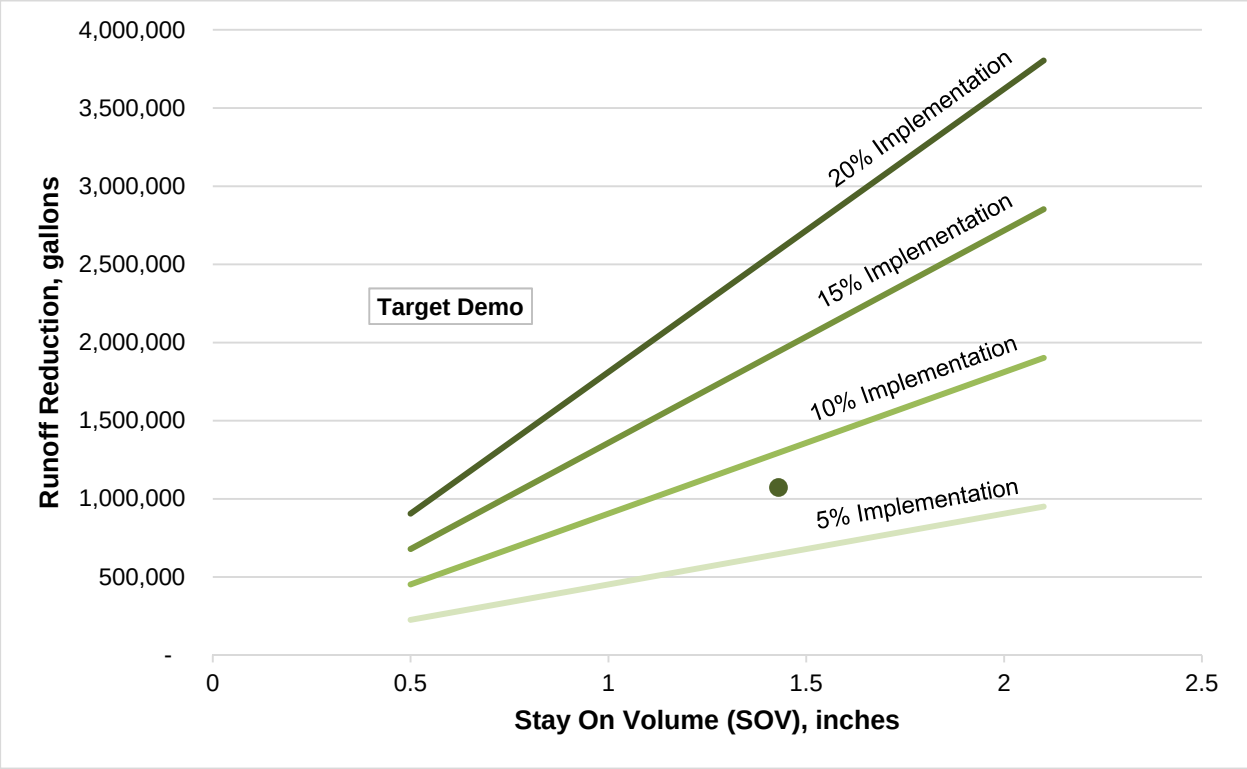


The baseline scenario reflects a condition where no GI is implemented to manage stormwater runoff from impervious areas. The City-owned properties generate approximately 47 million gallons (MG) from a 2-year, 24-hour rainfall. This makes up about 20% of the runoff from the CSS area as shown in Figure 3-.

The generic scenarios represent varied levels of GI implementation targeting impervious surfaces on City properties. The generic scenarios demonstrate the City's potential to reduce runoff by using GI to manage 5%, 10%, 15%, and 20% of impervious areas on City property. The runoff reduction estimated for each of the percentages is depicted in Figure 3-7.

Lastly, the target demonstration scenario is tailored to the specific City land use subcategories analyzed in Table 3-4. The target demonstration scenario can be used to set goals based on a target area managed with GI implementation or a volume reduction of runoff. Recall from Section 3.1.3, undeveloped and unused land and parks were opportunities for regional controls. This has been reflected in the target demonstration scenario by incorporating a larger SOV for those properties. The target demonstration scenario may be used as a tool to customize a strategy to achieve the performance of one of the generic scenarios from above. The runoff reduction from the target demonstration is represented by the point marker in Figure 3-7.

Figure 3-7
Assessment of GI Potential for Runoff Reduction on City Property in the CSS Area



The target demonstration scenario achieves a runoff reduction between the 5% and 10% GI implementation scenarios. Adjusting parameters, such as SOV goal, for a specific land use subcategory would result in a revised target runoff reduction value. The City may develop a specific target or a generic goal for the GI program as part of implementation of the GI Plan using this assessment as a tool. In order to achieve any goal for runoff reduction for GI, it may be necessary to locate potential GI project areas. The process for identifying GI project areas is discussed in Section 3.3

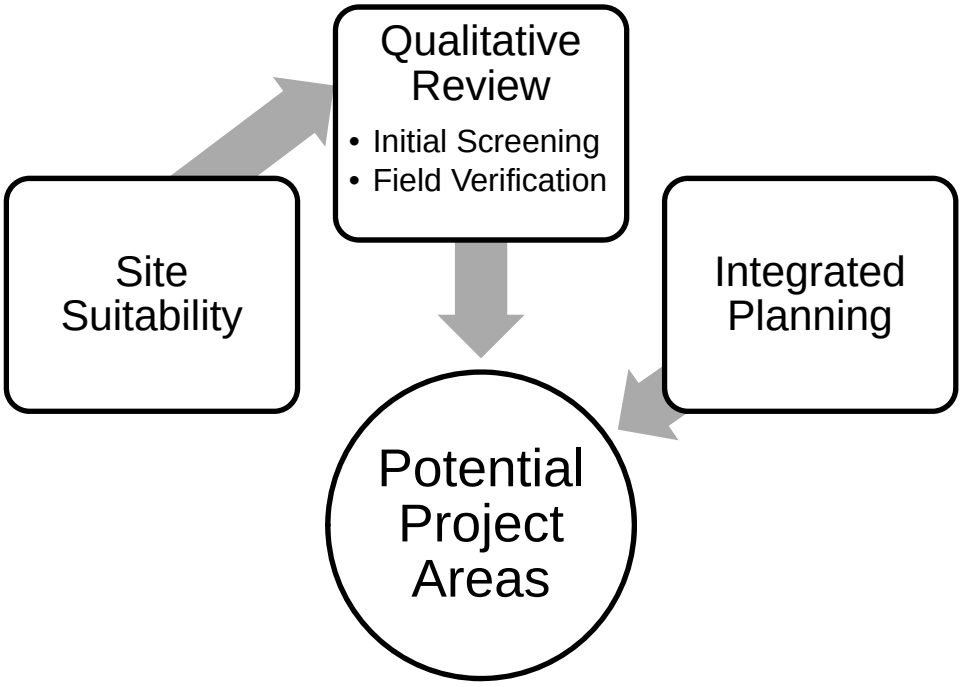
3.3 Project Area Identification Process

This subsection demonstrates the process for identifying potential GI project areas in the CSS area that can help the City progress toward the target demonstration from Section 3.2. The project area identification process was applied to the City-owned properties. The process used to identify potential GI project areas consisted of:

1. A site suitability analysis;
2. A qualitative review; and
3. Integrated planning efforts.

The project area identification process, shown in Figure 3-8, resulted in a list of potential project areas that are incorporated into the GI Plan. Each of the steps of the project area identification process is discussed below.

Figure 3-8
Project Area Identification Process



3.3.1 Site Suitability

The successful implementation of the GI controls and GI strategies identified in Section 2.0 rely on a thorough understanding of the existing physical characteristics of the CSS area. Therefore, the first step of the project area identification process consists of a site suitability analysis. The site suitability analysis was performed to objectively identify parcels within the CSS area that are best suited for a wide range of GI controls based on the existing physical characteristics of the CSS area.

The physical characteristics of the CSS area may impact the effectiveness, the ease of installation, and costs of GI controls in a particular location. Depending on the existing characteristics, standard design of GI controls may require modification. These implications must be understood in order to identify the most suitable locations for potential GI project areas within the CSS area.

The CSS area was characterized using GIS data from various local and regional sources. The following physical characteristics were reviewed due to their applicability in GI planning:

- Water resources;
  - Flood plains;
  - Water quality;
- Soils;
  - Hydrologic soil group (HSG);
  - Water table depth;
- Geology;
- Topography (Slopes);
- Other factors;
  - Protected areas; and
  - Historic areas.

The five categories were reviewed for the intended purpose of identifying potential GI opportunities as a siting exercise.

Water Resources

Proper placement and function of GI requires consideration of the existing water resources in the CSS area. The CSS area is contained within the Tennessee River-Nickajack Lake Upper and the Chattanooga Creek watersheds. The Tennessee River forms the western and northern boundaries of the CSS area, and Chattanooga Creek is located south of downtown Chattanooga bordering Sewershed 4 and Sewershed 5. Citico Creek is located north of downtown Chattanooga. The main branch of Citico Creek flows through Sewershed 7 before discharging into the Tennessee River. The water resources, including 100-year and 500-year flood plains, are displayed in Figure 3-9.

Flood Plains

Flood-prone areas pose a risk for many GI controls. Many GI controls rely on void spaces in various layers of soil and stone to filter and infiltrate stormwater runoff into the ground or to provide subsurface storage. Floods carry fine particles that can clog these soil and stone systems rendering them ineffective in managing stormwater runoff and increasing maintenance burdens.

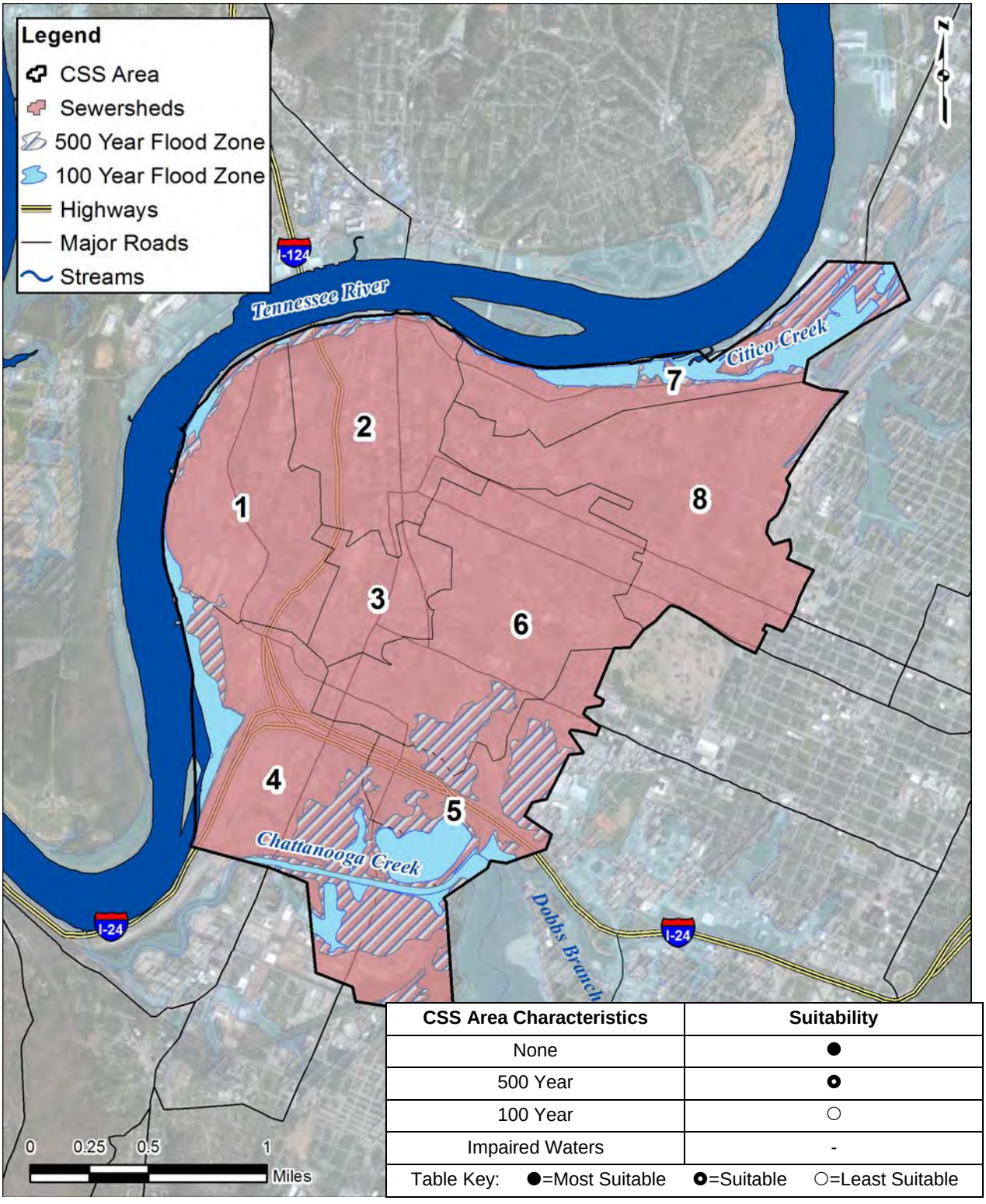
The 100- and 500-year flood plains for the Tennessee River are mostly contained within the steep banks of the river. Flood plains for Chattanooga Creek extend through portions of Sewersheds 4, 5, and 6. The flood plains associated with Citico Creek are located within Sewershed 7.

Potential sites located outside the 100- and 500-year flood plains are best suited for implementation for all GI controls. Areas within the 500-year flood plain are suited for all controls, but may need additional maintenance. GI controls consisting of stone storage beds or pervious surfaces are not recommended for implementation within the 100-year flood plain.

Water Quality

Each of the existing water resources within the CSS area have been identified as impaired waters for causes such as excessive nutrients (e.g., nitrate, nitrite, or phosphorus), low dissolved oxygen, E. Coli, anthropogenic habitat alterations, dioxins, creosote, and/or polychlorinated biphenyls. The GI controls incorporating soils and vegetation are filters for many pollutants found in typical urban stormwater runoff. Where soils and vegetation are not feasible per the RMG and Chapter 31 City Code, manufactured devices may be an appropriate alternative.

Figure 3-9
Water Resources Map for the CSS Area



CSS Area Characteristics	Suitability
None	●
500 Year	◘
100 Year	○
Impaired Waters	-
Table Key: ●=Most Suitable	◘=Suitable ○=Least Suitable

Soils

Soils are an important characteristic to consider when identifying the most suitable locations for the various GI controls. The soil type and condition (disturbed or undisturbed) impact the ability for GI controls to infiltrate stormwater. The soil types and conditions within the CSS area are shown in Figure 3-.

Two attributes of the CSS area soil types provide critical information for determining the most effective GI controls: HSG and water table depth. These are discussed in the following subsections. The soil types, the HSG, the water table depth, and the composition of the CSS area are summarized in Figure 3-10.

Table 3-5
USDA Soil Type Summary for CSS Area

Soil Type	Description	HSG	Water Table Depth (cm)	Percent of CSS Area
CdC	Colbert-Urban land complex, 2% to 12% slopes	D	114	16%
FwD	Fullerton-Urban land complex, 3% to 40% slopes	B	>200	15%
SfB	Sequatchie-Urban land complex, 2% to 7% slopes	B	>200	11%
Ur	Urban land (disturbed)	D	>200	58%

Hydrologic Soil Group

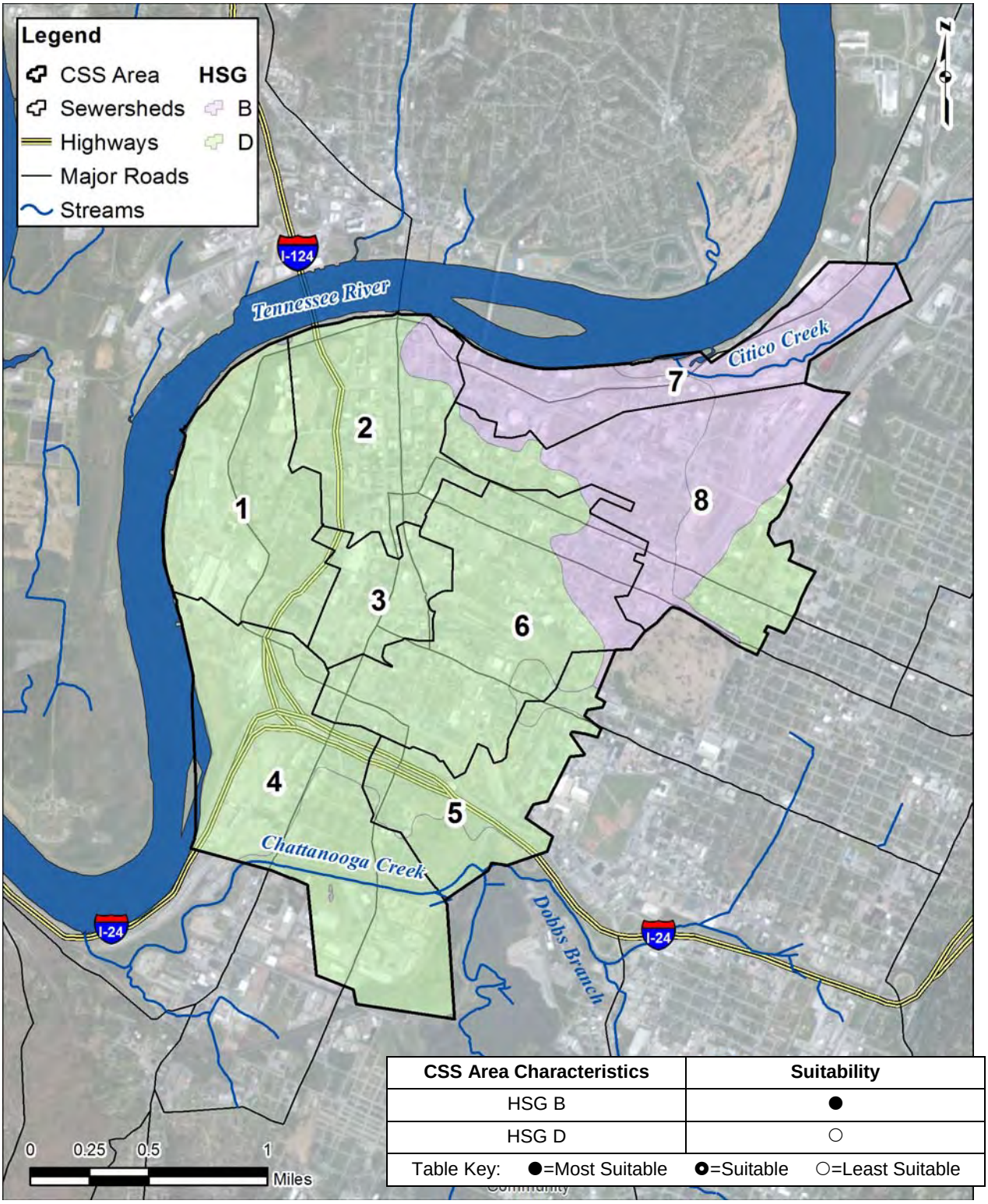
Soils that are best suited for GI controls are composed primarily of sand. These soils are classified by the United States Department of Agriculture (USDA) as HSG Type A and B soils. Sandy soils have high infiltration rates which are ideal for infiltration of stormwater runoff. Soils made up of silt and clay reduce the capacity for infiltration and are less suitable for a variety of GI controls. These soils that have little to no infiltration capacity are HSG Type C and D soils.

According to the USDA data, approximately 74% of the CSS area is HSG Type D soils. The remaining area is HSG Type B. There are no HSG Type A or C soils identified in the CSS area.

In the areas where HSG Type B soils exist, GI controls that infiltrate stormwater may be acceptable. However, since these are not HSG Type A soils, site-specific infiltration tests should be conducted to determine the infiltration rate of the soil. If SOV is the treatment method, perforated underdrains that distribute and equalize SOV along GI cells or non-perforated pipes that convey volumes between cells may be beneficial. In contract, underdrains that convey SOV off site, thus short circuiting mandates for zero discharge of the SOV target storm within 72 hours, are not allowed.

Throughout the remainder of the CSS area, where there are HSG Type D soils, infiltrative GI controls must be installed with underdrains. These GI controls will function as filters improving the water quality, and as detention controls reducing the peak rate of the stormwater runoff.

Figure 3-10
Hydrologic Soil Group Map for the CSS Area



CSS Area Characteristics	Suitability
HSG B	●
HSG D	○
Table Key: ●=Most Suitable	◘=Suitable ○=Least Suitable

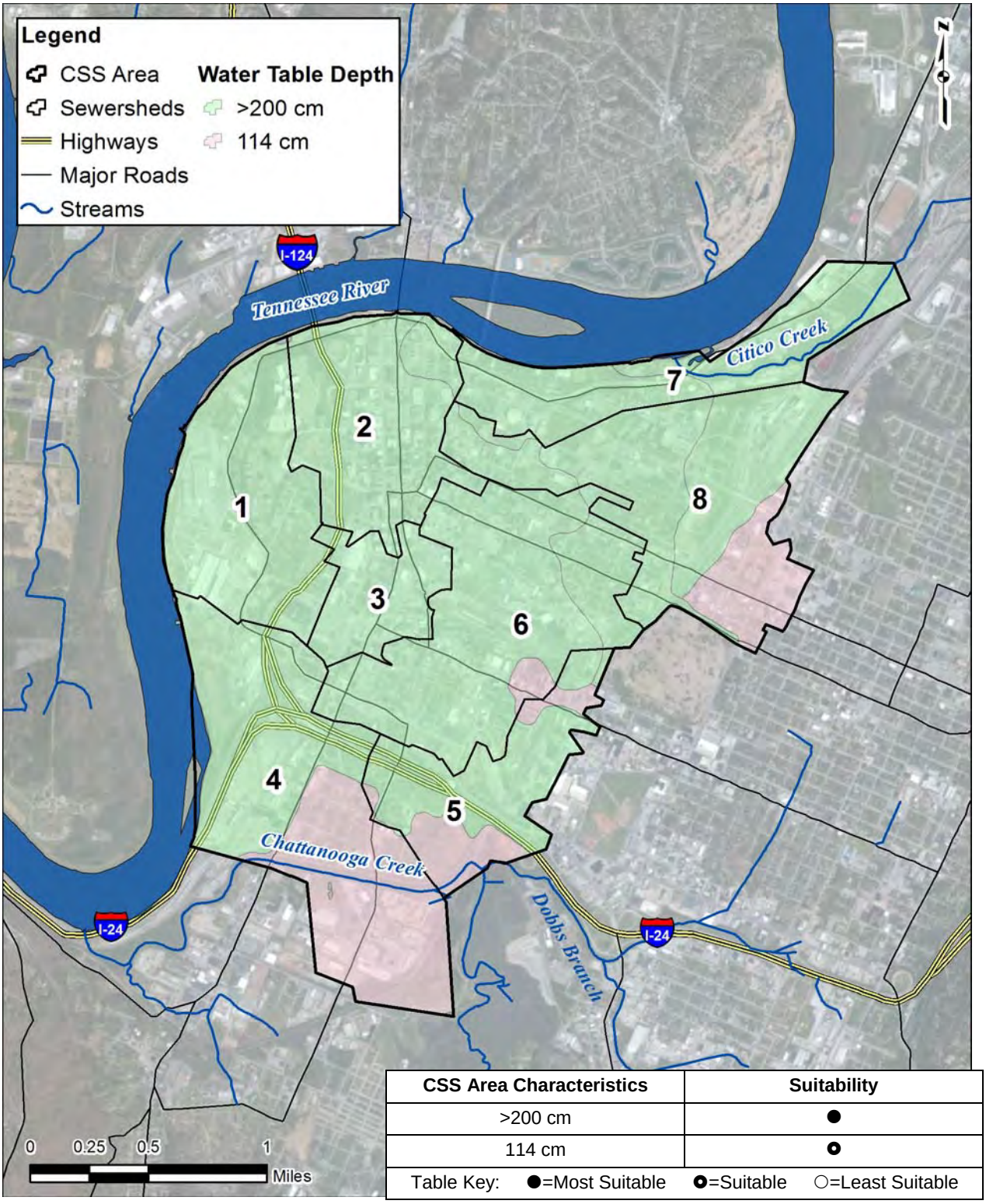
Water Table Depth

The water table depth of groundwater can also dictate selection and design criteria for GI controls. High water tables could reduce the storage capacity of GI controls or eliminate potential infiltration. In many cases, infiltration beds can be incorporated with other GI controls to achieve higher storage volumes. However, the depth to water table measured from the ground surface should factor into the projected performance of the GI control.

According to USDA Web Soil Survey data, approximately 84% of the CSS area has a water table depth rated greater than two (2) meters (>200 cm), or over six (6) feet. The remaining 16% of the CSS area is rated at 1.14 meters (114 cm), or just under four (4) feet.

Due to the potential complexity of each site's characteristics, a thorough understanding of each site's groundwater system should be evaluated prior to GI implementation. Some areas may be more complex due to a shallow groundwater table. Throughout the areas rated as >200 cm, the design parameters documented in the RMG for max depth shall govern. These areas are the most suitable for the range of GI controls. In areas rated 114 cm, site investigations on the local water table should be performed to determine the maximum depth allowable for GI controls with stone storage beds. However, these areas may provide some opportunities for restorative practices relying on groundwater for maintaining summer pools.

Figure 3-11
Water Table Depth Map for the CSS Area



CSS Area Characteristics	Suitability
>200 cm	●
114 cm	⊙
Table Key: ●=Most Suitable	⊙=Suitable ○=Least Suitable

Geology

The geology of a region may dictate the suitability of GI controls that infiltrate stormwater into the ground. Areas where limestone and dolomite are the predominant rock types pose challenges to GI control implementation and in some cases may not be suitable. The areas with high limestone and dolomite content can be classified as karst terrain. A geologic summary of the CSS area is located in Table 3-6, and the rock types are shown in Figure 3-12.

Table 3-6
Rock Type Summary in the CSS Area

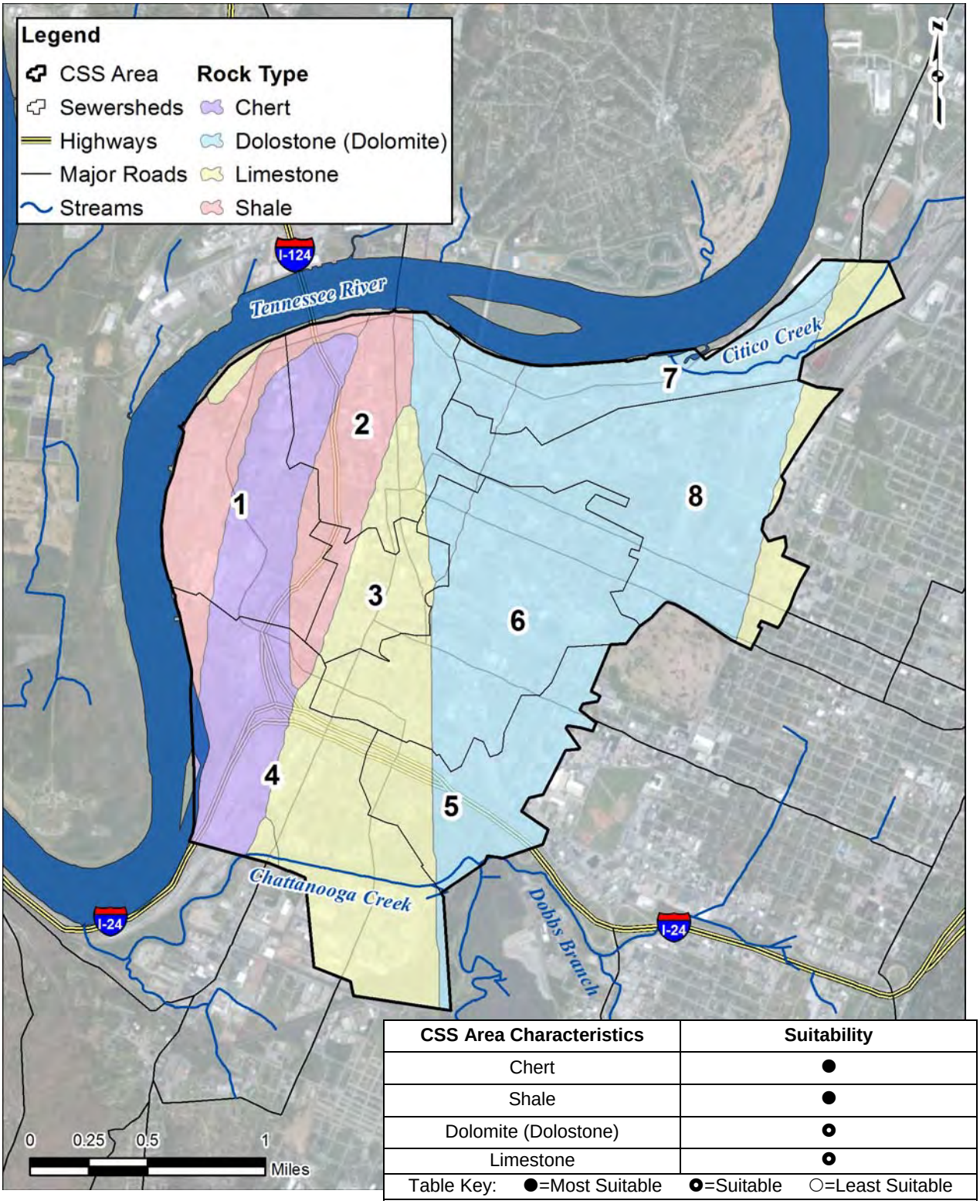
Rock Type	Percent of CSS Area
Dolostone (dolomite)	47%
Limestone	26%
Shale	13%
Chert	14%

Approximately 73% of the CSS area consists of karst rock types of limestone and dolomite. The remaining 27% is composed of shale and chert.

GI controls that rely primarily on infiltration are generally less suitable for karst areas than the remaining areas and the use of other GI controls may need to be considered. The planners and designers of the GI controls in these areas should recognize the risk of creating sinkholes, subsidence, or structural competency of the local geology due to advanced solutioning of the carbonate bedrock as a result of increased infiltration. Some risks can be mitigated in the early phases of the project by conducting geotechnical site investigations to determine the specific geologic and soil conditions at the site. Pending the investigations, there may be areas where additional considerations are deemed necessary, such as installation of underdrains, additional vegetation to uptake stormwater, or consideration of storage and reuse controls.

The areas composed mostly of shale and chert are generally better suited for a range of GI controls compared to karst topography. However, Chattanooga has a unique geologic formation called Chattanooga Shale. Chattanooga Shale contains varying amounts of pyrite which has the potential to contribute high pH levels to stormwater runoff. Design considerations such as avoidance, liners, and underdrains may be necessary when implementing GI where Chattanooga Shale is present. Site specific geologic investigations are recommended throughout the CSS area which will provide additional constructability information beyond the risks caused by infiltration of stormwater runoff.

Figure 3-12
Rock Type Map for the CSS Area



CSS Area Characteristics	Suitability
Chert	●
Shale	●
Dolomite (Dolostone)	⭘
Limestone	⭘
Table Key: ●=Most Suitable	⭘=Suitable ○=Least Suitable

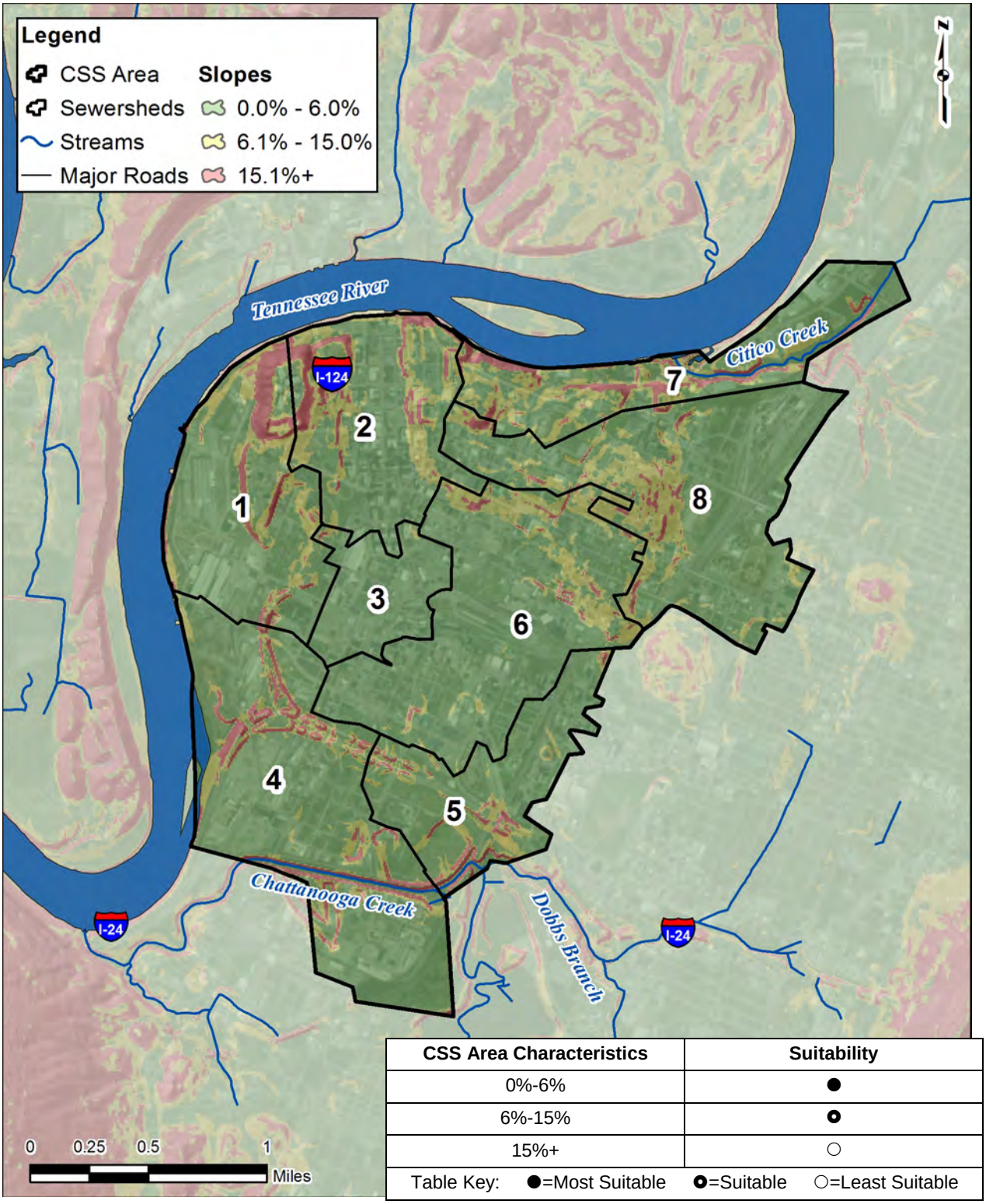
Topography

The efficiency and constructability of GI controls depend on the topography. The topography of an area can dictate the type of GI controls and additional design considerations that may be necessary. Steep slopes tend to accelerate the velocity of the stormwater runoff. Accelerated flows can bypass inlets, scour the soil media at the inlet, or even uproot newly planted vegetation. In addition, constructability can become a concern, and designing GI controls beneath steep slopes can make it more difficult to obtain preferred storage volumes.

A slope analysis was performed on the CSS area to identify the best suited locations for GI controls with respect to topography. The results of the analysis are shown in Figure 3-13.

In general, land with slopes ranging from 0%-6% are the most suitable for all GI controls. Locating GI controls on slopes that are 6% or greater require additional design considerations. The RMG dictates maximum slopes and requirements for many of the GI controls including pervious pavements, infiltration practices, bioretention areas, vegetated swales, vegetated filter strips and stormwater planters. The areas where the analysis displays slopes greater than 15% are generally the least suited for GI implementation. These areas should be protected and future development on these slopes should consider incorporating distribution underdrains, check dams, velocity dissipation, among other design considerations, to override excessive velocities, splash over and super-elevation around bends in conveyances, etc.

Figure 3-13
Slope Analysis Map for the CSS Area



CSS Area Characteristics	Suitability
0%-6%	●
6%-15%	⊙
15%+	○
Table Key: ●=Most Suitable	⊙=Suitable ○=Least Suitable

Other Factors

In addition to the CSS area characteristics discussed, protected areas and historic areas may also impact the suitability of GI control implementation. The following subsections discuss the findings of protected areas and historic areas within the CSS area.

Protected Areas

Protected areas are established and receive protection features to ensure their prolonged conservation because of environmental, cultural, or similar values. For purposes of GI suitability, the following sources were referenced to identify protected areas within the CSS area:

- World Database on Protected Areas (WDPA); and
- United States Fish and Wildlife Services (USFWS).

According to the WDPA, there are no protected areas in the CSS area (WDPA, 2013). Critical habitat, migratory bird conservation and national wildlife refuge system areas from the USFWS were reviewed and no data indicated these areas are present within the CSS area. Wetlands areas are incorporated as protected areas from the USFWS National Wetlands Inventory. There are few sparse wetlands located within the CSS area as shown in Figure 3-14.

In addition, the TDEC Division of Natural Areas (DNA) maintains a Natural Heritage Program which tracks over 1,100 rare and endangered plant and animal species across Tennessee. There are 72 species documented within Hamilton County. Areas where these species have been identified should also be protected. However, the designations of these areas should be determined as part of an environmental review following the siting of a potential project area.

Historic Areas

Chattanooga is rich with historical and architectural character. As such, five (5) local historic districts are identified by the Chattanooga Historic Zoning Ordinance. There are four residential local historic districts throughout the City, two of which are located within the CSS area: Fort Wood and Battery Place. These local historic districts are regulated by the Chattanooga Historic Zoning Commission (CHZC). The remaining historic district, the North Shore Commercial District, is regulated by the North Shore Design Review Committee and is not located within the CSS area. There are also clusters of regional historic districts which were identified in the 2030 Comprehensive Plan. In addition to historic districts, approximately 15 historical places are registered in the National Register of Historic Places in the CSS area. The historic districts and places are shown in Figure 3-15.

Historic areas are generally less suited for GI controls. Due to the age of the historic areas and value they provide the City, minimal risks should be taken with respect to implementing GI controls in historic areas. The City should avoid implementing infiltration practices in proximity to historic structures. Green roofs and rain barrels/cisterns are also discouraged to maintain the character of existing buildings. Coordination with the CHZC is necessary if an opportunity for GI implementation presents itself within historic areas.

Figure 3-14
Wetlands Map for the CSS Area

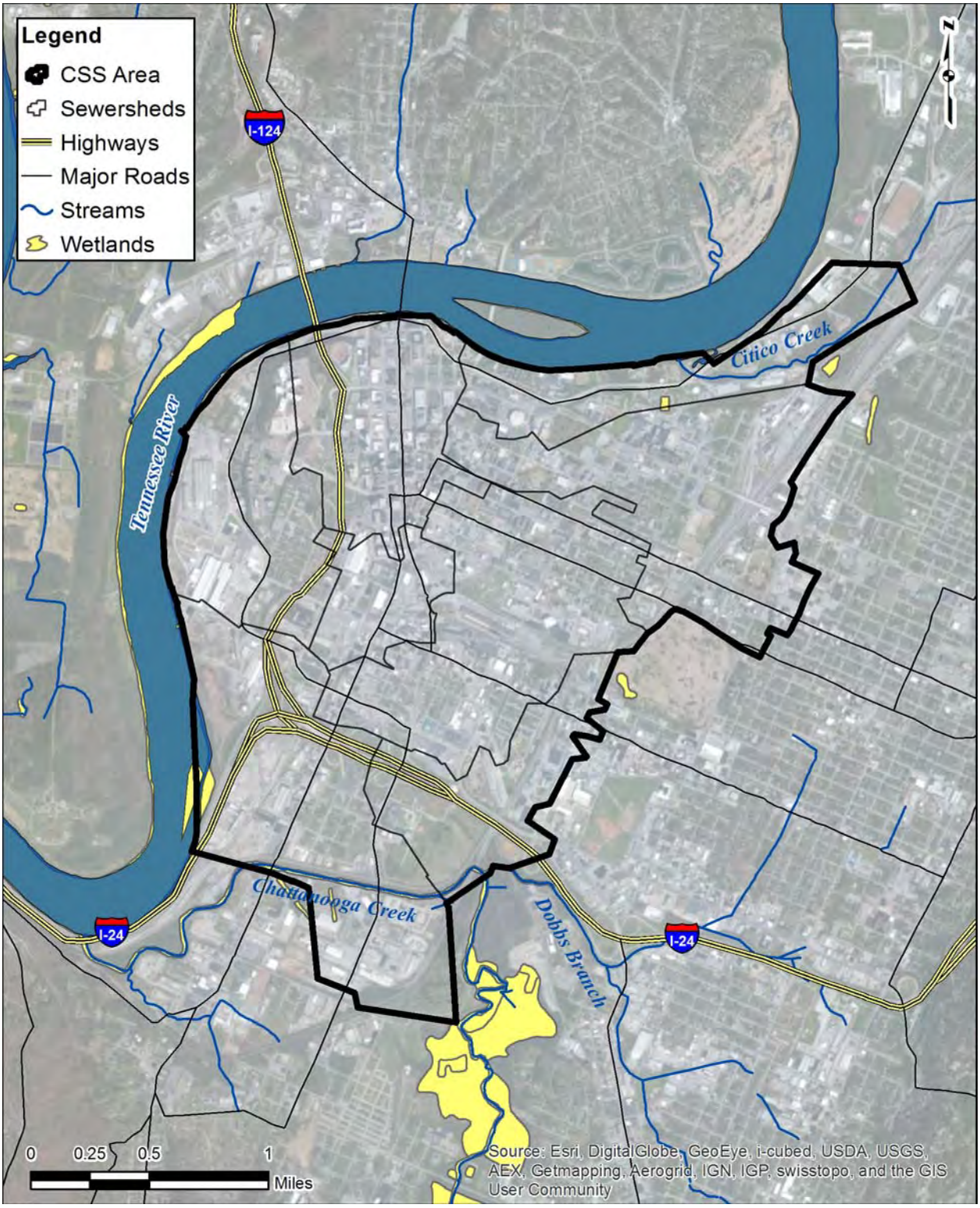
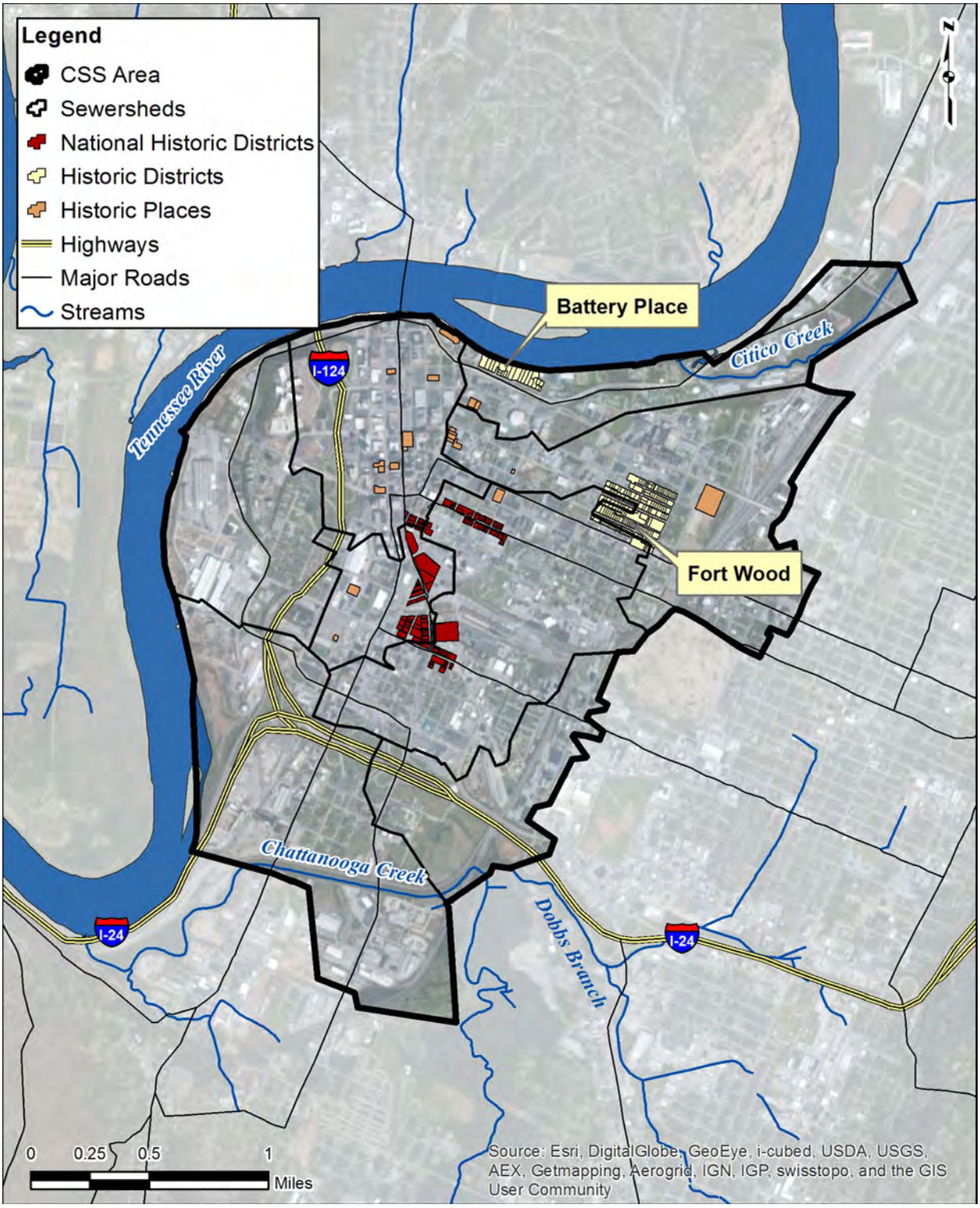


Figure 3-15
Historical Places and Districts Map for the CSS Area



Analysis

The site suitability analysis was performed using the physical characteristics discussed above. The spatial data from the CSS area physical characteristics were loaded into CommunityViz®, a software tool that incorporates spatial data sets to support decision making. Each of the characteristics were assigned a score: zero (0), one (1), or two (2). The higher the score, the more suitable the characteristic for a wide range of GI controls. The physical characteristics identified in the spatial data sets were scored according to the data in Table 3-7.

Table 3-7
Site Suitability Scoring Parameters

Site Suitability Parameter	CSS Area Characteristics	Score
Water Resources: Flood Plain	None	2
	500 Year	1
	100 Year	0
Water Resources: Water Quality[a]	Impaired Waters	-
Soil Type: HSG	B	2
	D	0
Soil Type: Water Table	>200 cm	2
	114 cm	1
Geology: Rock Type	Chert	2
	Shale	2
	Dolomite (Dolostone)	1
	Limestone	1
Topography: Slopes	0%-6%	2
	6%-15%	1
	15%+	0
Other Factors[b]	Protected and Historical Areas	-

[a]The entire CSS area contributes to impaired waters so parcels are all equally suited for GI with respect to Water Quality considerations.

[b]Other factors may or may not reflect the true suitability of GI control implementation. These factors must be assessed at the site level during planning and design phases of projects. Consult the appropriate regulatory authorities to provide environmental and historical determinations.

Each characteristic was associated with a parcel based on their relative proximity. CommunityViz® then computed a composite suitability score for each parcel. The results of the site suitability analysis for all properties in the CSS area and City-owned properties are

displayed in Figure 3-16 and Figure 3-17, respectively. The analysis revealed regions in the west and northeast of the CSS area that are generally more suitable for GI implementation. These areas are generally less developed than the downtown core, and the soils are likely less disturbed than other portions of the CSS area. The central area of the CSS poses the next most suitable grouping of parcels. This area is outside major flood zones and is void of bluffs or ridges that would hinder GI implementation.

Suitability for City ROW areas can also be determined from the CSS area site suitability analysis. Where the City ROW is adjacent to the most suitable parcels, these areas may also be considered most suitable for a wide range of GI controls. Conversely, City ROW located adjacent to least suitable parcels are least suited for a range of GI controls.

The results of the site suitability analysis were then subject to a qualitative review (see Section 3.3.2) to identify potential project areas for demonstration of the GI Plan.

Figure 3-16
Site Suitability Map for the CSS Area

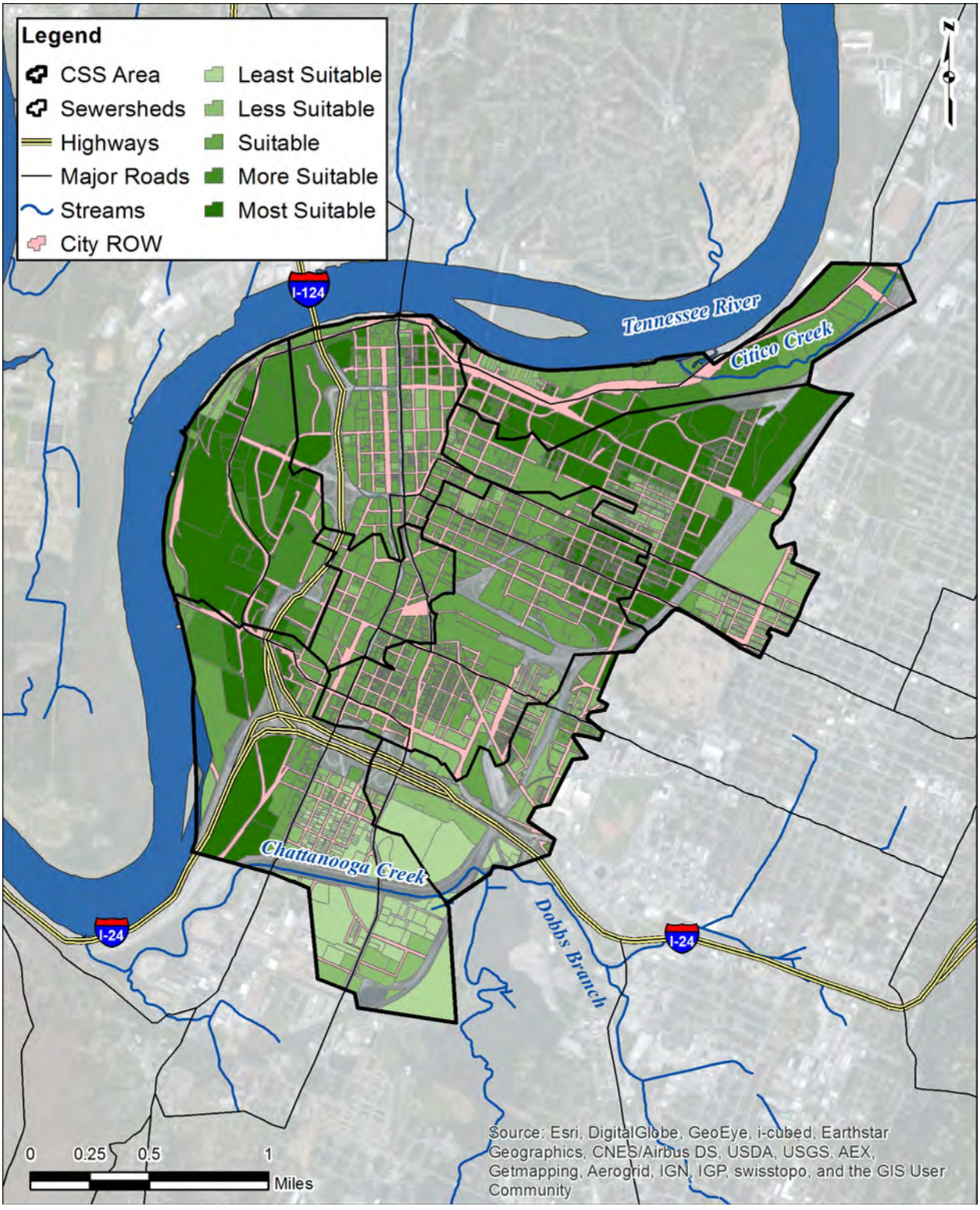
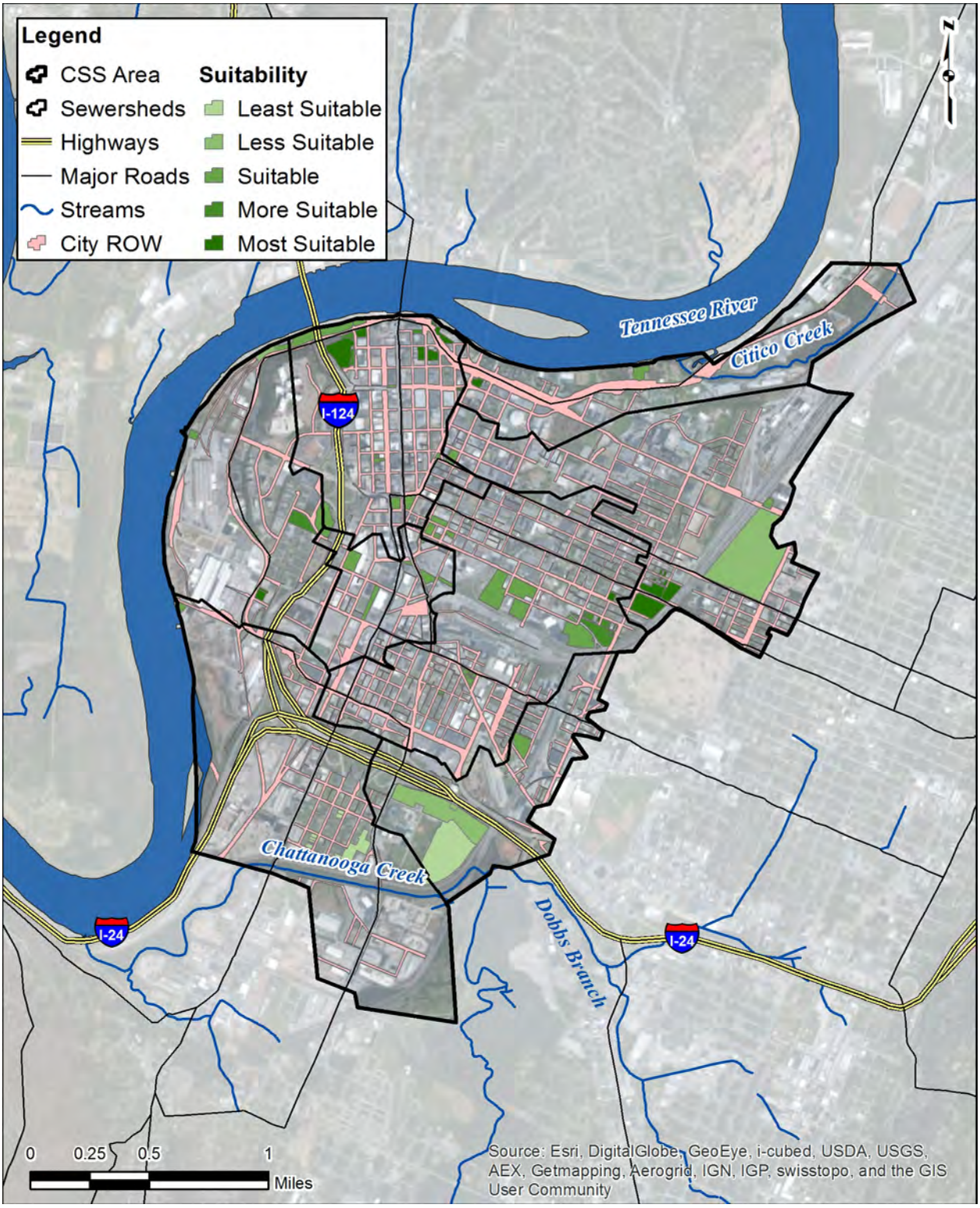


Figure 3-17
Site Suitability Map for City-owned Parcels for the CSS Area



3.3.2 Qualitative Review

The site suitability analysis identified the City-owned parcels throughout the CSS area that may be best suited for a wide range of GI controls. Using the raw suitability results, this subsection describes how to identify suitable GI project areas through a qualitative review. The qualitative review was performed in two steps: initial screening and field verification.

Initial Screening

In the initial screening step, the City-owned parcels with the highest suitability scores were:

- Sorted by land use;
- Grouped into clusters; and
- Reviewed using aerial imagery.

Sorting the parcels by land use allows potential project areas from the GI strategies identified in Section 2.2 to be considered in the project area identification process. This also allows the project area identification process to encourage coordination amongst the various City departments (e.g., Transportation Department for Green Streets).

Once sorted, the parcels with the highest suitability scores were grouped by combining smaller adjacent parcels with high suitability scores (e.g. adjacent tracts of vacant lots). The grouping process resulted in a total of 19 potential project areas as shown in Table 3-8.

Table 3-8
Initial Screening Potential Project Areas List

Site ID	Potential Project Area	Address	Land use	Strategy	CSS Sewershed	Owner	Owner2	Aerial Review Notes	Proceed with Field Verification
1	Warner Park / Chattanooga Zoo	301 N. Holtzclaw Ave.	Park	Green Space	8	City of Chattanooga	-	Good - A lot of space, existing water features, large parking facilities, courts/ball fields	Yes
2	Miller Park	928 Market St.	Park	Green Space	2	City of Chattanooga	-	Fair - High public visibility, existing water feature, already "greened" with tree cover	Yes
3	Fort Negley Park	1704 Mitchell Ave	Park/Vacant Land	Green Space	6	City of Chattanooga	-	Fair - Small space, opportunity for revitalization, at street corner for sewer accessibility	Yes
4	E. 10th St. Playground	1003 E. 10th St.	Park	Green Space	6	City of Chattanooga	-	Fair - Small space, opportunity for revitalization, at street corner for sewer accessibility	Yes
5	Ross's Landing Park	101 Riverfront Pkwy	Park/Vacant Land	Green Space	2	City of Chattanooga	-	Fair - Large open space, along River, small benefit to CSO - sheet runoff to river	Yes
6	Hunter Museum of American Art	2 Bluff View	Park/Commercial	Green Partnership	2	City of Chattanooga		Fair - Steep slopes, along river, private facility	Yes
7	Harris Johnson Park	41 W. 28th St.	Park/Vacant Land	Green Space	4	City of Chattanooga	-	Good - Open space, adjacent vacant properties	Yes
8	Long St. and W. 26th St.	2603 Long St.	Park/Vacant Land	Green Space	4	City of Chattanooga	-	Good - Open space, opportunity for revitalization, at street corner for sewer accessibility	Yes
9	Williams St. (W. 28th St. to W. 27th St.)	2709 Williams St.	Vacant Land	Green Space	4	City of Chattanooga	-	Fair - Existing CSOTF	Yes
10	Howard School and I-24 Corridor	E. 25th St.	Vacant Land/Community Services	Green Space	5	City of Chattanooga	-	Good - Open space, visibility from I-24, educational opportunity, proximity to school, existing water feature/facility, CSOTF	Yes
11	E. 8th St. (O'Neal St. to Central Ave.)	1237 E. 8th St.	Vacant Land/Community Services	Green Space	8	City of Chattanooga	EPB of Chattanooga	Fair - Corner lots, scattered homes within space, potential partnership with Chattanooga Heart Lung and Vascular Clinic and EPB.	Yes
12	274 E. 10th St.	274 E. 10th St.	Vacant Land	Green Parking	6	City of Chattanooga	Attn: Real Property Department	Fair - High impervious %, small parking lot, revitalization opportunity	Yes
13	600 E. 11th St.	600 E. 11th St.	Vacant Land	Green Space	6	City of Chattanooga	Attn: Real Property Dept.	Poor - Development in progress, railroad area potential for naturalization	No
14	E. 12th St. (Central Ave. to Park Ave.)	E. 12th St.	Vacant Land/Community Services	Green Parking	6	City of Chattanooga	-	Good - High impervious %, parking, vacant lot space, public works fleet space?	Yes
15	245 Walnut St.	245 Walnut St.	Vacant Land	Green Parking	2	Chattanooga Downtown Redevelopment Corp.	C/O Michael MC Mahan	Poor - Already "green," newer development, parking only	No

Table 3-8
Initial Screening Potential Project Areas List

16	145 Cherry St.	145 Cherry St.	Vacant Land	Green Space	2	Chattanooga Downtown Redevelopment Corp.	C/O Michael MC Mahan	Poor - Already "green," newer development	No
17	214 Lookout St.	214 Lookout St.	Schools	Green Schools	2	Chattanooga Downtown Redevelopment Corp.	C/O City of Chattanooga	Poor - New development	No
18	225 E. 11th St.	225 E. 11th St.	Transportation/Community Services	Green Parking	6	City of Chattanooga		Fair - small lot, Fair test site	Yes
19	AT&T Field Parking	201 Power Alley	Transportation/Community Services	Green Parking	2	Sports Authority of City of Chattanooga	C/O Mayor's Office	Fair - high visibility sports complex	Yes

The sites were then reviewed using aerial imagery in Google Earth. The aerial imagery provided additional insight beyond the existing CSS area characteristics for the suitability of GI. The aerial imagery provides information on the layout of buildings and parking lots, extent of the existing tree canopy, and age of the development. Using these qualitative factors, a rating of Good, Fair, or Poor was applied to each of the 19 sites. Sites that received a Good rating had available space and redevelopment potential. Sites that received a Poor rating included natural sites, sites already containing GI, or sites that were recently developed. The Fair sites were in the middle of the spectrum.

The 15 Good and Fair sites were selected for field verification and are noted as such in Table 3-8. A summary of statistics from the initial screening process are displayed in Table 3-9.

Table 3-9
Qualitative Review of Potential GI Project Area Locations

Qualitative Rating	# of Parcels/Sites
Good	5
Fair	10
Poor	4
Total	19

Field Verification

The qualitative review was completed with an additional level of screening by conducting field assessments to verify the sites were conducive to GI implementation. The 15 sites that were assigned good and fair ratings were visited by a field engineer, and an assessment form was completed for each. The field assessment was conducted to:

- Confirm the site location and address;
- Confirm land use at the site;
- Assess public visibility;
- Assess existing ground cover;
- Assess ability to collect stormwater runoff from adjacent upland areas; and
- Identify the probable GI controls to be used at site.

The assessment forms and photo documentation of the 15 assessed sites are included in Appendix G. As a result of the field verification and the qualitative review, the five (5) sites in Table 3-10 were identified as suitable sites to cross reference with existing planning documents in the next step, Integrated Planning.

Table 3-10
Five (5) Suitable Sites from Field Verification

Suitable Site Name	Address	GI Strategy
Warner Park	301 N. Holtzclaw Ave.	Green Open Spaces
Ross's Landing	101 Riverfront Pkwy	Green Open Spaces
Howard School and I-24 Corridor	320 E. 25th St.	Green Open Spaces
E. 12th St. (Central Ave. to Park Ave.)	E. 12th St.	Green Streets
AT&T Field Parking	201 Power Alley	Green Parking

3.3.3 Integrated Planning

From Section 3.3 above, the project area identification process has three (3) major steps:

1. A site suitability analysis;
2. A qualitative review; and
3. Integrated planning efforts.

The final step of the project area identification process, and parallel to the suitability sites, is integrated planning. Integrated planning consisted of a review of the public feedback, requests, and recommendations found in the following regional planning documents:

- Downtown Plan Chattanooga 2025 (Downtown Plan);
- Comprehensive Plan 2030;
- Chattanooga-Hamilton County/North Georgia Long-Range Transportation Plan 2040 (TransPlan 2040);
- City Five (5) Year Plan Fiscal Years 2011-2015 (City Five Year Plan); and
- Other local sources:
  - River City Company; and
  - Chattanooga Zoo Master Plan.

The projects contained in the aforementioned plans consisted of specific stand-alone GI projects and general project areas that may allow for integration of GI controls. Though several projects were reviewed in the planning documents, an intradepartmental City workshop was conducted to identify the pertinent project areas in some phase of planning that could be used to demonstrate the development of concept plans and the project rating system. The project areas integrated with planning documents selected for demonstration are shown in Table 3-11.

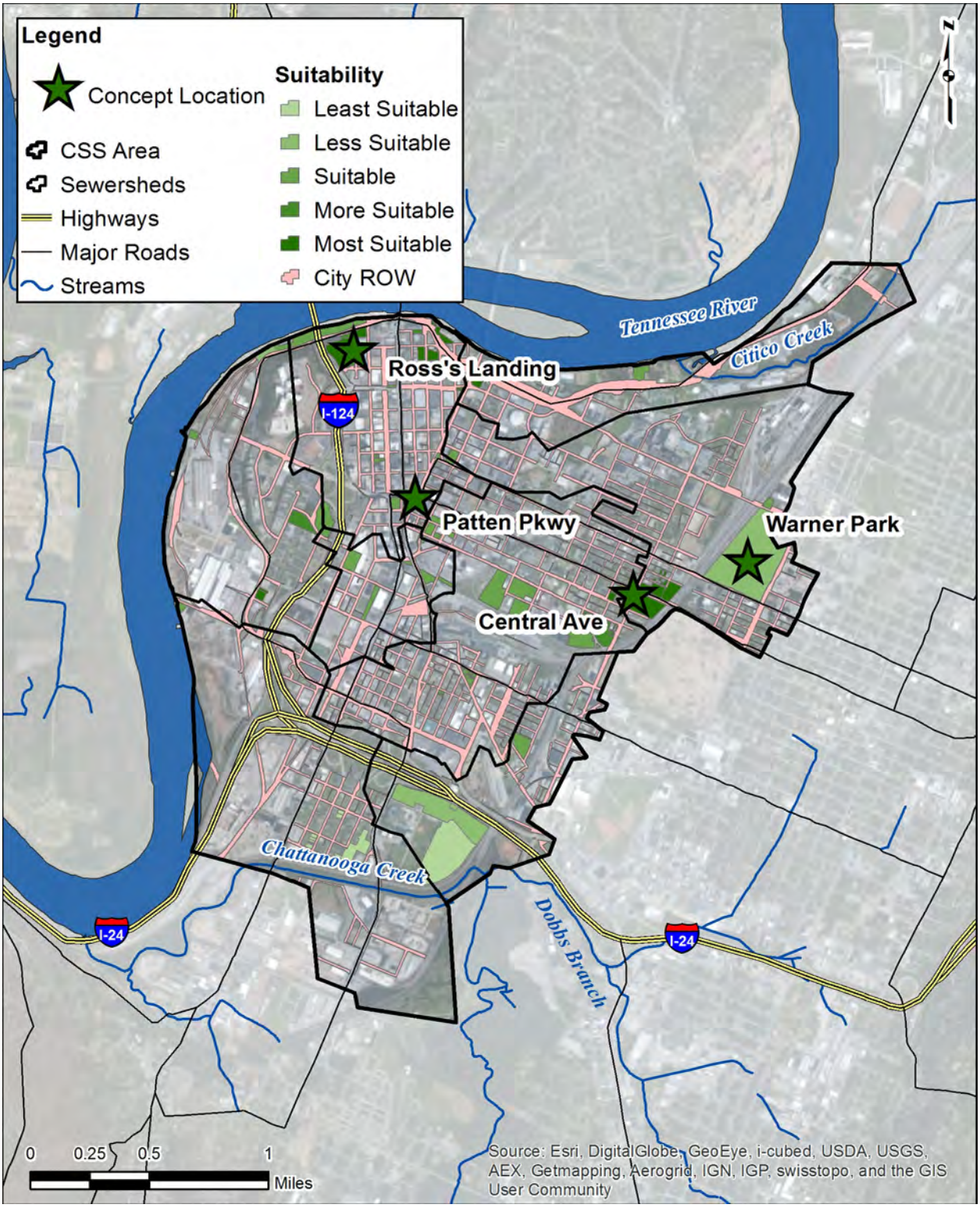
Table 3-11
Integrated Planning Decision Matrix for Selecting Sites to Demonstrate the Project Rating System

Potential Project Area	Source of Potential Project Area	Workshop Decision for Rating System Demonstration
Warner Park	Suitability Analysis and Chattanooga Zoo Master Plan	Yes
Ross's Landing	Suitability Analysis	Yes
Howard School and I-24 Corridor	Suitability Analysis and Downtown Plan	No
E. 12th St. (Central Ave. to Park Ave.)	Suitability Analysis	No
AT&T Field Parking	Suitability Analysis	No
Patten Parkway[a]	Downtown Plan and River City Company (adjacent to Miller Park)	Yes
Central Avenue[a]	TransPlan 2040 (adjacent to suitable parcels from the Suitability Analysis)	Yes
[a]Project areas were added as result of workshop to review the suitable sites resulting from Field Verification.		

The project areas selected to demonstrate the project rating system are shown in Figure 3-18 and are listed below:

1. Central Avenue;
2. Patten Parkway;
3. Ross's Landing; and
4. Warner Park.

Figure 3-18
Demonstration Concept Projects Map for the CSS Area



3.4 Project Rating System

A project rating system was developed to assist in the prioritization of potential project areas that could be identified through implementation of the GI Plan. The project rating system includes 12 priority items divided into economic, environmental, and social criteria. A scoring system ranging from zero (0) to two (2), with two (2) being the best, was applied. Weight factors can be used to assign importance to a certain criteria. The sum of all the weight factors should equal 100%. The current weight factors are generic and generally uniform but could be adjusted to reflect GI program goals during implementation of the GI Plan.

The categorized priority items are described in the sections below followed by a summary of the scores and the weights for each of the 12 priority items in Table 3-12.

3.4.1 Economic Variables

Project Cost/Stormwater Detained and Captured

The performance of GI was initially measured against typical grey infrastructure costs of other communities with CSSs which included Knoxville, TN; Louisville, KY; St. Louis, MO; Milwaukee, WI; and Portland, OR. Performance of grey infrastructure for tunnels or storage facilities in these communities range between $2.50/gal and $4.00/gal. If GI is more effective than the grey infrastructure baseline (less than $2.50/gal), a score of two (2) was assigned. If the GI is comparable to the grey infrastructure baseline (greater than or equal to $2.50/gal and less than $4.00/gal), a score of one (1) was assigned. If the GI is less effective than the grey infrastructure baseline (greater than or equal to $4.00/gal), a score of zero (0) was assigned.

Partnership Opportunity

Rarely does GI affect one isolated property or member of the community. Capitalizing on good relationships and common community goals increases the probability for a project's success. The total cost of the GI project could be greatly impacted by some form of partnership. If a party, or land owner, is supportive of the potential project and demonstrates available financial resources (either through donations, grants, price matching, or other infrastructure investments), a score of two (2) was assigned. If a party, or land owner, is supportive of the potential project but is not willing to offer financial resources, a score of one (1) was assigned. If a party, or land owner, is unsupportive of the potential project, a score of zero (0) was assigned.

Available Space

Some GI controls require more space than others to implement. The need for property acquisition or gaining additional easements may be necessary, which can inflate a low-cost project. Available space may correlate to the total acreage of the potential property, but often is constrained by existing buildings, facilities, or utilities. If the project has sufficient space available on City-owned land and avoids the need to acquire additional property, a score of two (2) was given. If the project has space available on City-owned land but will require the limited acquisition of additional property, a score of one (1) was given. If the project requires extensive space not available on City-owned land and will require acquisition of additional property, a score of zero (0) was given.

Operation and Maintenance

Operation and maintenance costs add to the life-cycle cost of a GI control. The project was assigned a Low, Medium or High maintenance rating based on the highest maintenance burden of any individual control. The GI controls and their respective maintenance burdens were documented in Table 2-1.

If the project contains controls with a Low maintenance burden, a score of two (2) was given. If the project contains controls with a mix of Low and Medium (or Medium only) maintenance burdens, a score of one (1) was given. If the project contains controls with a High maintenance burden, a score of zero (0) was given.

Reliability

Some GI projects are more reliable in removing stormwater runoff from the CSS than others. To account for reliability, some factor of safety may require consideration resulting in upsizing a particular GI control. This size increase impacts the total cost of the project when compared to the resulting stormwater runoff that is detained or captured. If the GI project removes stormwater from the CSS through disconnection, off-loading to a natural system, or ties into a designated storm sewer system, a score of two (2) was given. If the GI project removes stormwater from the CSS through storage or infiltration, a score of one (1) was given. If the GI project removes stormwater from the CSS through capture and reuse methods (whose performance may be reliant on user operation), a score of zero (0) was given.

Feasibility

Additional costs of a GI project may be incurred due to the site layout and unforeseen variables during the early planning stages. For example, an environmental assessment may have previously been conducted at the potential project area which may complicate implementation of GI controls thus negatively impacting the feasibility of the project. A feasibility of Low, Medium, and High attempt to provide a level of uncertainty of the project based on the data available. If the feasibility of the project was indicated as High, a score of two (2) was given. If the feasibility of the project was indicated as Medium, a score of one (1) was given. If the feasibility of the project was indicated as low, a score of zero (0) was given.

3.4.2 Environmental Variables

CSS Sewershed Impact

GI projects were rated based on the CSS sewershed where they are located. The various CSS sewersheds were prioritized according to their receiving waters and the potential for sanitary sewer overflows (SSOs) based on the City's SSO Reports.

Sewersheds 4, 5 and 6 contribute runoff to Chattanooga Creek. Chattanooga Creek carries much less flow than the Tennessee River. GI projects located within CSS Sewershed 4, 5, or 6, receive a score of two (2).

Sewersheds 1, 2, 3, 7 and 8 contribute overflows to the Tennessee River. The magnitude of runoff generated in Sewersheds 7 and 8 are higher. GI projects located within CSS Sewersheds

7 or 8 receive a score of one (1). If the project location is in Sewersheds 1, 2, or 3, a score of zero (0) was assigned.

Total Site Impervious Area

Impervious surfaces increase the rate and volume of stormwater runoff, inhibit groundwater recharge, increase the urban heat island effect, decrease habitat, and contribute to poor air quality. Using GI projects to reduce impervious area on highly impervious sites offers numerous environmental benefits. If the project is located on a site with greater than 75% impervious cover, a score of two (2) was given. If the project is located on a site with impervious cover ranging from 50%-75%, a score of one (1) was given. If the project is located on a site with less than 50%, a score of zero (0) was given.

Environmental Clean-up Sites

Environmental clean-up sites are designated areas throughout the City that contribute pollutants in excess of those typically found in urban stormwater to various water resources and the CSS. EPA approves and encourages remediation and redevelopment of these sites and has provided guidance for applicable GI controls such as that discussed in the document, Implementing Stormwater Infiltration Practices at Vacant Parcels and Brownfield Sites (EPA, 2013).

If the GI project is coordinated with a brownfield redevelopment site, a score of two (2) would be given. Brownfield sites present opportunity for grant funding and revitalization. Brownfield assessment grant site locations were updated by the RPA and provided to the City on July 18, 2013. The brownfields located throughout the CSS area are displayed in Figure 3-19.

If the project is located on some other property designated as a hot area, and remediation is conducted, a score of one (1) was given. These hot areas may include presence of foundry sands generated from the metal casting industry. If the project does not positively impact a hot area, a score of zero (0) would be assigned.

Increase Tree Canopy

A greater number of trees in an urban setting provides a higher quality of life by improving the air quality, decreasing stormwater runoff, and reducing heat island effects. A general goal identified in the Downtown Plan 2025 was a 15% tree canopy cover. The priority scoring of the potential projects reflects this 15% goal.

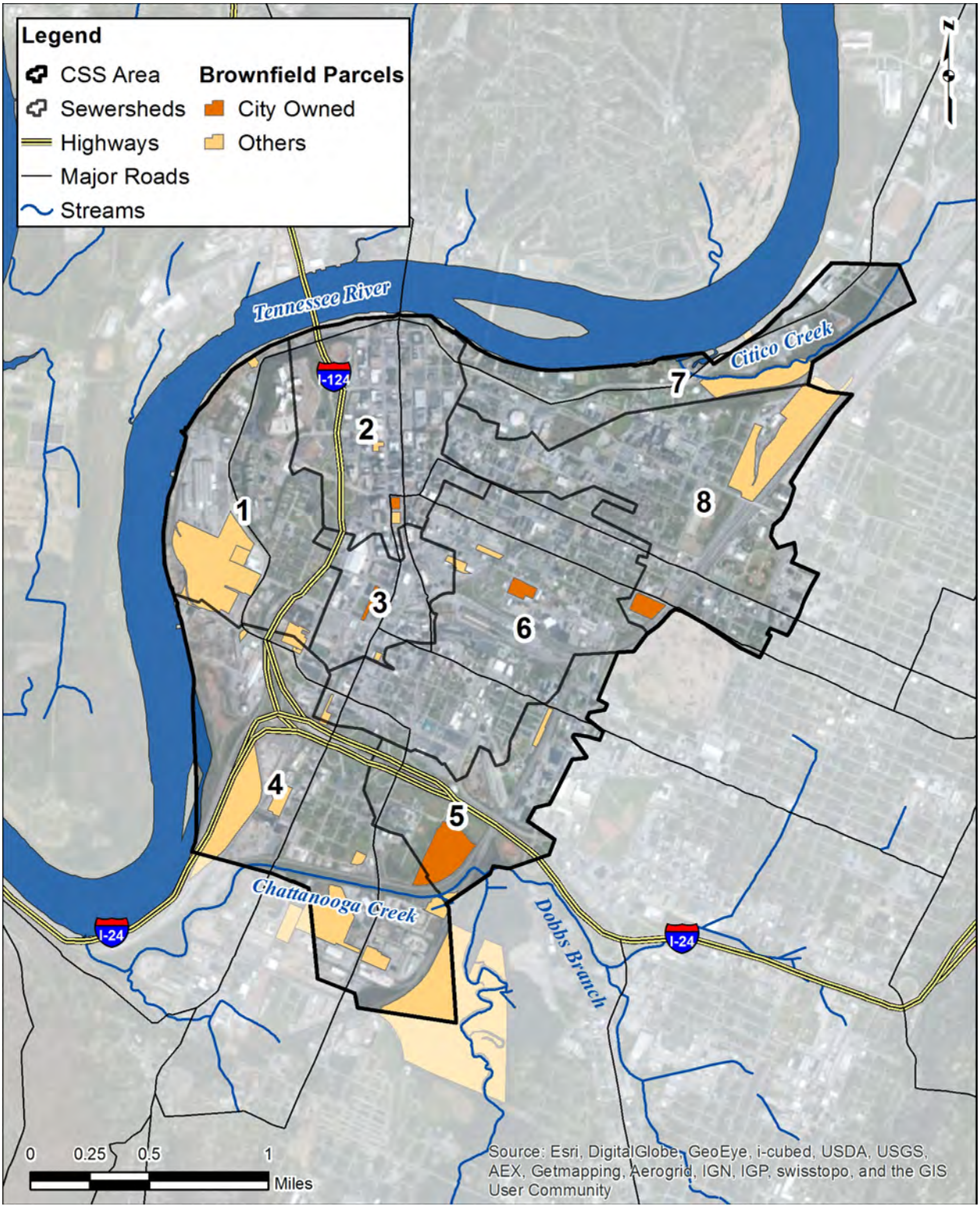
If the project area currently has less than 15% canopy cover and the proposed project will increase the tree canopy cover to greater than 15%, a score of two (2) was given. If the project will increase the tree canopy, a score of one (1) was given. If the project does not introduce new trees or trees are removed resulting in a reduction of tree canopy cover, a score of zero (0) was given.

Tree canopy should be determined using one of the following methods:

1. The canopy of each tree would be measured in the field and the area calculated,
2. The type of tree planted and the ideal canopy used to track overall canopy, or

3. Have another survey performed, similar to the one performed by American Forests as reported in the June 2010 document entitled, "Urban Ecosystem Analysis City of Chattanooga, Tennessee."

Figure 3-19
Brownfields Map for the CSS Area



3.4.3 Social Variables

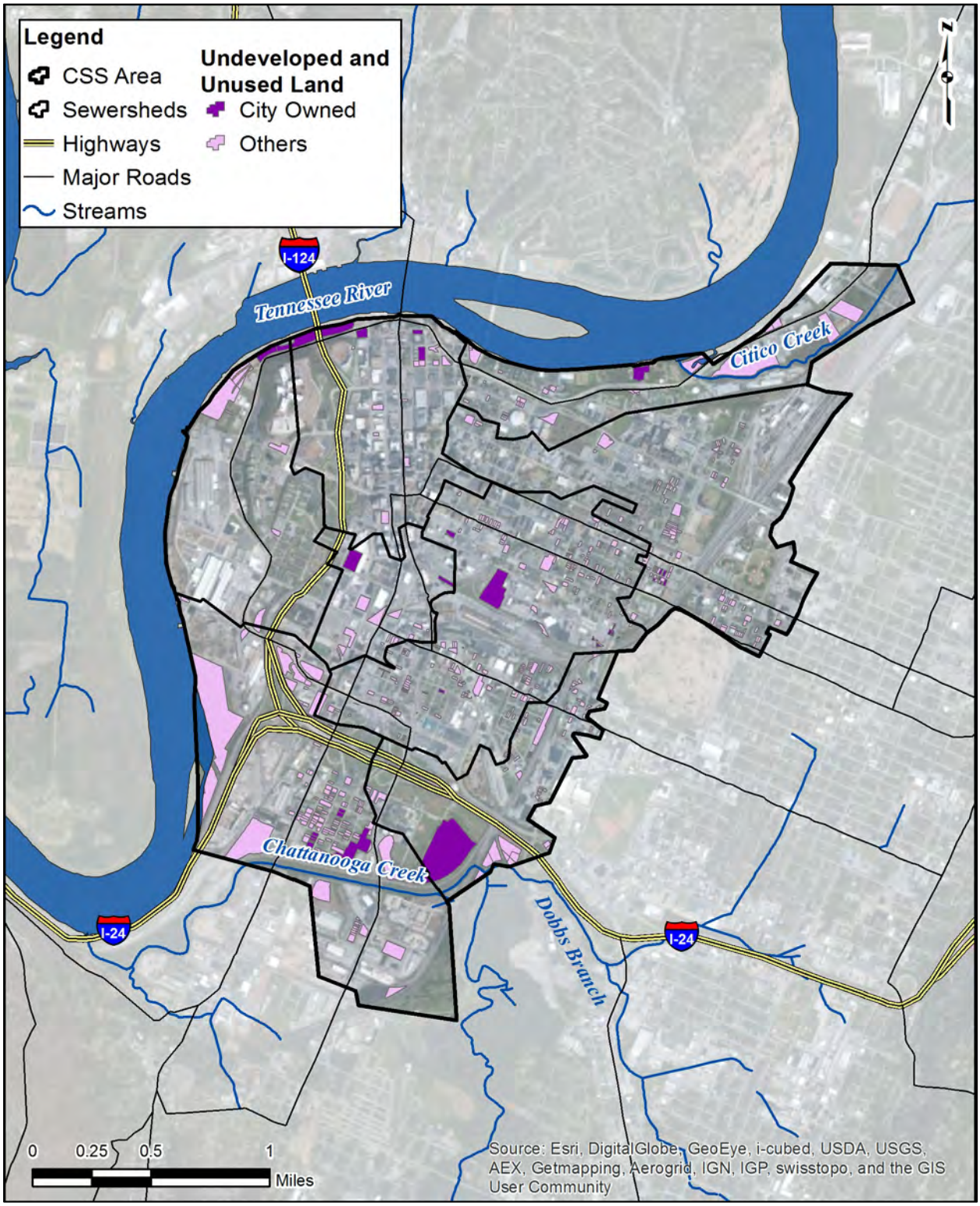
Integration with Planning Documents

A potential GI project will receive a higher priority if it is in alignment with projects or initiatives contained in the City Five Year Plan, Downtown Plan, Comprehensive Plan 2030, or TransPlan 2040. If the potential project is specified in one of the planning documents, a score of two (2) was given. If the potential project is located within or adjacent to proposed natural systems (i.e. Greenway) or public spaces identified in the planning documents, a score of one (1) was given. If the potential project does not align with one of the aforementioned plans, a score of zero (0) was given.

Vacant and Unused Land Revitalization

There are approximately 40 City-owned parcels designated as vacant, undeveloped, or unused lands in the CSS area. A potential GI project will receive a higher priority score if these properties are targeted for implementation of GI controls. If the potential GI project is incorporated with the demolition or removal of structures on undeveloped and unused land, a score of two (2) was assigned. If the potential GI project is implemented on undeveloped and unused land but the existing land cover does not contain impervious surfaces, then a score of one (1) was assigned. If the potential GI project is not used to revitalize undeveloped and unused lands, then a score of zero (0) was assigned. The undeveloped and unused properties throughout the CSS area are shown in Figure 3-20 and are defined by the county land use codes 900-970.

Figure 3-20
Undeveloped and Unused Land Map for the CSS Area



3.4.4 Summary

The economic, environmental, and social variables are summarized in Table 3-12. The variables, scores, and associated generic weights may be used to prioritize potential GI projects for the GI program. The City may adopt additional criteria or adjust weights throughout the GI program to reflect "lessons learned" through the process.

Table 3-12
Project Rating System Summary

Priority Items	Criteria	Score	Weight
Project Cost/Stormwater Detained and Captured ($/gal)	< $2.50/gal	2	10%
	$2.50/gal-$4./gal	1	
	> $4.00/gal	0	
Partnership Opportunity	Supportive with financial resources	2	10%
	Supportive with limited resources	1	
	Non-Supportive	0	
Available Space	City-owned, no acquisition necessary	2	10%
	Publicly owned, limited acquisition necessary	1	
	Acquisitions necessary	0	
Operation and Maintenance	Low	2	10%
	Medium	1	
	High	0	
Reliability	Remove from CSS	2	5%
	Storage/Infiltration	1	
	Capture/Reuse	0	
Feasibility	High	2	5%
	Medium	1	
	Low	0	
CSS Sewershed Impact	Sewersheds 4, 5, and 6	2	10%
	Sewersheds 7 and 8	1	
CSS Sewershed Impact	Sewersheds 1, 2 and 3	0	10%
Total Site Impervious Area	> 75%	2	10%
	50-75%	1	
	< 50%	0	
Environmental Clean-up Sites	EPA Brownfields	2	5%
	Others	1	
	None	0	

Table 3-12
Project Rating System Summary

Increase Tree Canopy	Increase from <15% to > 15%	2	5%
	Net Increase	1	
	No Change or Net Decrease	0	
Integration with Planning Documents	Project Specified in Planning Document	2	10%
	Within or Adjacent to Proposed Natural Systems or Public Space	1	
	No	0	
Vacant and Unused Land Revitalization	Unused and Undeveloped Land with Structures or Impervious Surfaces	2	10%
	Unused and Undeveloped Land without Impervious Surfaces	1	
	Not Unused and Undeveloped Land	0	

3.5 Demonstration of GI Program Project Process

The GI Program project process was intended to demonstrate a process for implementation of a variety of GI strategies across the CSS area. It provides steps to continually update tracking, rating and concept development of potential GI project areas. Key elements of this process include:

- Continual suitability assessment;
- Continual qualitative mapping and analysis;
- Continual site assessment;
- Integrated planning;
- Identifying candidate projects for GI implementation;
- Tracking potential projects; and
- Visualizing the project through Concept Plan development to determine:
    - Impervious area managed;
    - GI control capture volumes;
    - Percent (%) tree canopy provided; and
    - Estimate of probable cost.

Demonstration projects were developed utilizing the elements outlined above. The purpose of the demonstration projects is to illustrate how each category of the project ranking system is completed for a potential project.

The key step in developing all the categories necessary for project rating is the development of a project concept plan. The concept plans provide a vision for suggested GI controls that may be suitable to implement at the project area. With a concept sketch and planning level unit cost data, the project rating system can be applied.

The assumptions used to develop the demonstration concept plans are documented in Appendix H. Unit costs were developed and applied to the demonstration concepts in order to determine the Project Cost/Stormwater Detained and Captured rating criteria. The development of the unit costs is documented in Appendix I. The spreadsheet tool used to rate the potential projects is provided with specific demonstration concept information in Appendix J. The demonstration project list is shown in Table 3-13 with results from the rating system.

Table 3-13
Demonstration Concept Rating System Results Summary

Project ID	Potential Project Name	Strategy	CSS Sewershed	Impervious Area Managed (ac)	Rating Score	Status
1	Central Avenue	Green Streets	5	13.12	150	Demonstration
2	Patten Parkway	Green Street	2	1.09	135	Demonstration
3	Ross's Landing	Green Open Space	2	0.49	115	Demonstration
4	Warner Park	Green Facility	8	2.00	100	Demonstration

4.0 Public Participation

This section establishes the public participation process that allows the City to provide GI information to the community.

The public participation process in this plan consists of the following key elements:

- Organize for City participation;
- Determine the level of community engagement; and
- Identify techniques to provide information.

4.1 Organize for City Participation

The City is responsible for providing information to the community which may be accomplished through committee coordination. The committees and community groups that may be engaged in public participation include the:

- Chattanooga Stormwater Regulations Board (Existing); and
- Green Infrastructure Committee (Potential).

Furthermore, the City may meet with implementation department GI coordinators to discuss organizing an intra-departmental committee, the Green Infrastructure Committee (GIC), to collaborate between the City and the Chattanooga Stormwater Regulations Board (CSRB).

The structure and function of the existing and potential committees is described in the following subsections.

4.1.1 Chattanooga Stormwater Regulations Board (Existing)

The CSRB, an existing board appointed by the Mayor to review stormwater issues and to make recommendations to City Council. The CSRB may be used to assist the City in carefully considering how existing and proposed rules, regulations, policies, and ordinances would enable the use of GI.

4.1.2 Green Infrastructure Committee (Potential)

The GIC, currently not in existence, would include internal City stakeholders with a thorough knowledge of the City departments, responsibilities, and rules and regulations. The GIC would seek to successfully balance the obligations of the City and the requests of the community. The GIC could carefully consider how existing and proposed rules, regulations, policies, and ordinances affect the community stakeholders.

4.2 Determine Level of Engagement

The internal City committees associated with GI should determine the level of engagement for public participation feasible for each section of the GI Plan for individual stakeholders. The levels will vary according to the desired level of public participation, available resources, and implementation schedules for the particular section and stakeholder. Once the right level of engagement for individual stakeholders has been determined for each section within the GI Plan, identify techniques to provide information to community stakeholders.

4.3 Identify Techniques to Provide Information

Some of the key tools the City has identified as a potential means to convey information to the community stockholders includes the following:

- Websites;
- Social media;
- Printed materials; and
- Mass media.

These techniques are outlined in Table 4-1.

Table 4-1
Techniques to Provide Information

Technique	Number of Participants	Best Suited For
Websites	Unlimited	All projects and audiences where access is available. Literacy issues can be overcome by using voice and video.
Social Media	Unlimited, but multiple platforms may appeal to certain demographics.	All projects and audiences where access is available. Literacy issues can be overcome by using voice and video.
Printed Materials	Unlimited, but printing and mailing costs could be a consideration	Projects with manageable numbers of stakeholders if printing and mailing are to be done. May not be appropriate where literacy is an issue.
Mass Media	Unlimited	Larger projects of widespread interest; use of press and media could form part of the overall communication strategy.

5.0 Implementation

The Implementation of the GI Plan is outlined in four (4) components:

1. GI management strategy;
2. GI project planning;
3. Policy actions; and
4. Public participation.

5.1 GI Management Strategy

In order for the City to Implement GI, a management strategy must first be developed to manage the implementation options. This step will be critical to the development of goals and timelines used for implementation of the GI Plan.

5.1.1 Goal of the GI Management Strategy

The goal of this management strategy is to identify a process for the City to follow as they prepare for the implementation of GI. As the City organizes to implement the GI Plan, they will consider the following key implementation departments for representation within the proposed GI Plan:

- WRD;
- Department of Public Works;
    - City Engineering and WQP;
- CDOT;
- ECD;
    - LDO; and
    - RPA.

5.1.2 Key Elements of the GI Management Strategy

The City will need to identify elements of the management strategy which may include the following:

- GI Plan manager from one of the key departments;
- GI coordinators from each implementation department;
- GIC;
- Existing resources including but not limited to funding, personnel, equipment and implementation time allotted for each element of the GI Plan;

- GI project planning including project area identification, tracking, assessment and rating within the implementation departments;
- Assessment metrics for the implementation of GI so that funding may be equitable across the implementation departments and success may be reported succinctly;
- Existing policy actions or projects currently funded for planning, design, or construction; and
- Assessment of cost and benefit for GI Plan.

5.1.3 GI Management Strategy Steps

The management strategy will be developed through coordination within the implementation departments. The management strategy may include the following steps;

1. Identify one of the key departments as the GI Plan manager;
2. The GI Plan manager may prepare and execute a presentation of the GI Plan to the GI coordinator for each implementation department with a focus on the key elements identified above;
3. The GI Plan manager may collaborate with departmental coordinators to amend the goals of the GI Plan based on feedback from the presentation and workshop;
4. The strategic management goals will identify the allocation of funds, personnel, equipment, time and related resources for implementation of the GI Plan;
5. GI Plan manager, in collaboration with GI, may formalize the GIC and define its role in GI project planning, policy actions, and public participation for the GI Plan; and
6. GI Plan manager may facilitate the development of a memorandum of understanding (MOU) for intra-departmental coordination to implement the GI Plan.

5.2 GI Project Planning

The City has outlined the process for identifying potential project areas in Section 3.3. The steps for project area identification included suitability analysis, qualitative review, and integrated planning. The following are critical components to have in place prior to developing a working list of potential GI projects:

- Identify potential project areas from the process outlined in Section 3.3;
- Coordinate an integrated planning process to develop a list of potential GI project areas from planning documents, capital improvement programs, and existing projects or plans;
- Create a project database to track potential projects;
- Develop concept plans to demonstrate the anticipated performance of the candidate GI projects;
- Utilize the project rating system provided in Section 3.4 to prioritize projects for implementation;
- Use MOUs to identify funding mechanisms and potential project ratings to determine a schedule for project implementation.

5.3 Policy Actions

EPA developed the Water Quality Scorecard (Scorecard) to assist communities with incorporating GI practices at the municipal, neighborhood, and site levels. The City's WQP has completed the baseline summary of the Scorecard results and is under review by the City. The Scorecard has identified several potential updates and revisions to regulations, codes and standards. In order to combine the strategies of this GI Plan and those the City is currently seeking, it may be beneficial to implement some of the following items:

- Establish the GIC consisting of individuals with a thorough knowledge of the City departments, responsibilities, and rules and regulations. The GIC will coordinate and analyze results from the comprehensive review as well as the strategies presented in this plan. Prioritize revisions and updates to City codes, ordinances, and policies;
- Develop a specific schedule with task assignments for prioritized revisions. Reference council meeting schedules and ensure approvals of updates and revisions can be conducted within a realistic timeframe;
- Develop additional policy language targeted to remove GI barriers identified from the Scorecard;
- Review and revise City standard design guidelines and details to incorporate GI, such as revising street specifications to allow for pervious pavements for sidewalks and other surfaces within City ROW;

- Develop an interdepartmental process for comprehensive review of existing City codes, policies, ordinances, regulations and laws to identify barriers to the implementation of GI within the CSS area;
- Update the list of City-owned properties within the CSS area available for implementation of GI strategies and controls identified in the GI Plan; and
- Develop a program to prioritize the utilization of undeveloped, vacant and underused City-owned property for implementation of GI strategies and controls.
- Review and amend GI Plan as appropriate.

5.4 Public Participation

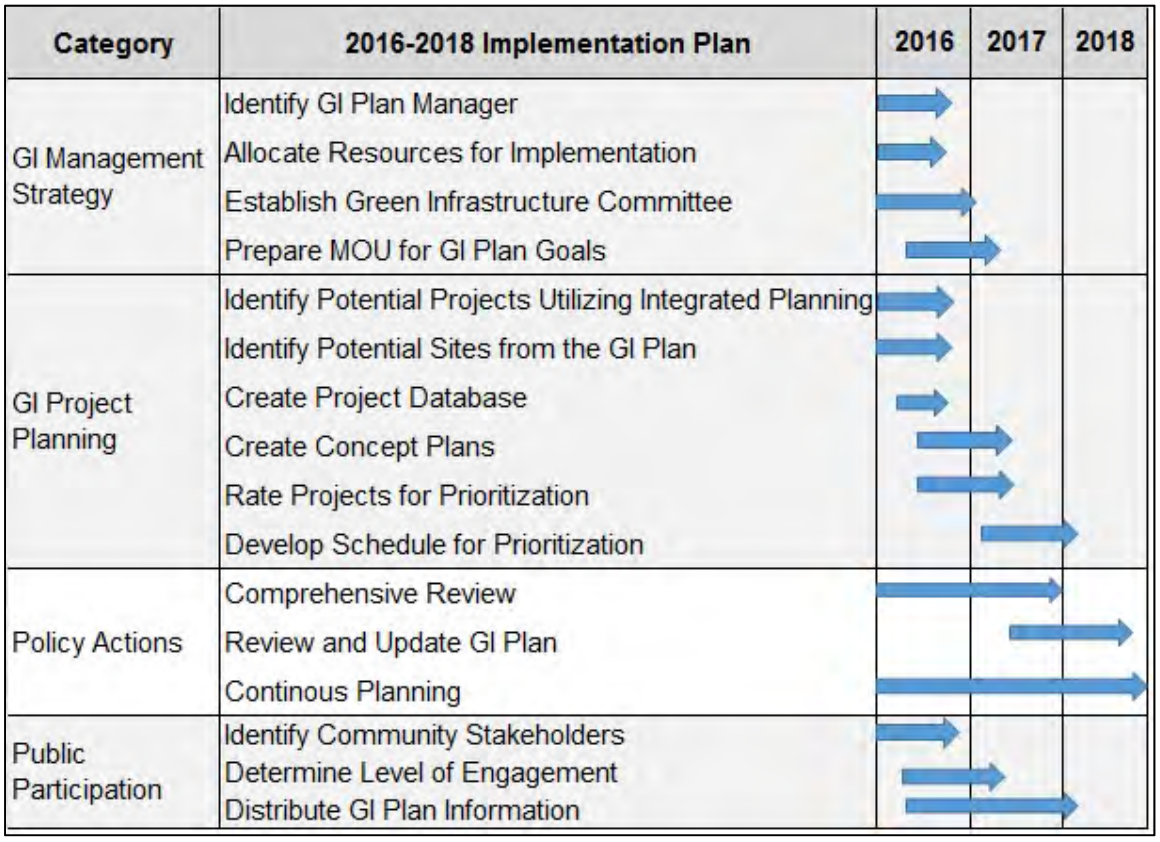
The public participation process establishes a framework to provide information to community stakeholders regarding GI. The following are key measures the City may choose to execute to ensure the success of the GI Plan's Public Participation process:

- Identify stakeholders and the opportunities stakeholders provide to the implementation of the GI Plan;
- Establish the level of engagement for each community stakeholder;
- Establish a process for the GIC to inform internal stakeholders regarding the obligations of the City with respect to the GI Plan;
- Coordinate a social media and website presence focused on distribution of information on GI;
- Augment current printed media efforts under their education and outreach programs to directly inform community stakeholders about GI;
- Make Fact Sheets (see Appendix B) available to the appropriate community stakeholders;
- Unify community stakeholder interests into central messages that reflect the purpose of the GI Plan;
- Coordinate a series of workshops intended to provide information on "how to" and DIY projects to support the GI Plan within the Green Housing strategy;
- Conduct interviews, work sessions, and focus groups with various City departments and related government stakeholders to identify potential GI opportunities located on City-owned property and to develop partnerships related their activities and initiatives.

5.5 Implementation Schedule

The implementation schedule for the GI Plan is shown in Figure 5-1 based on calendar year.

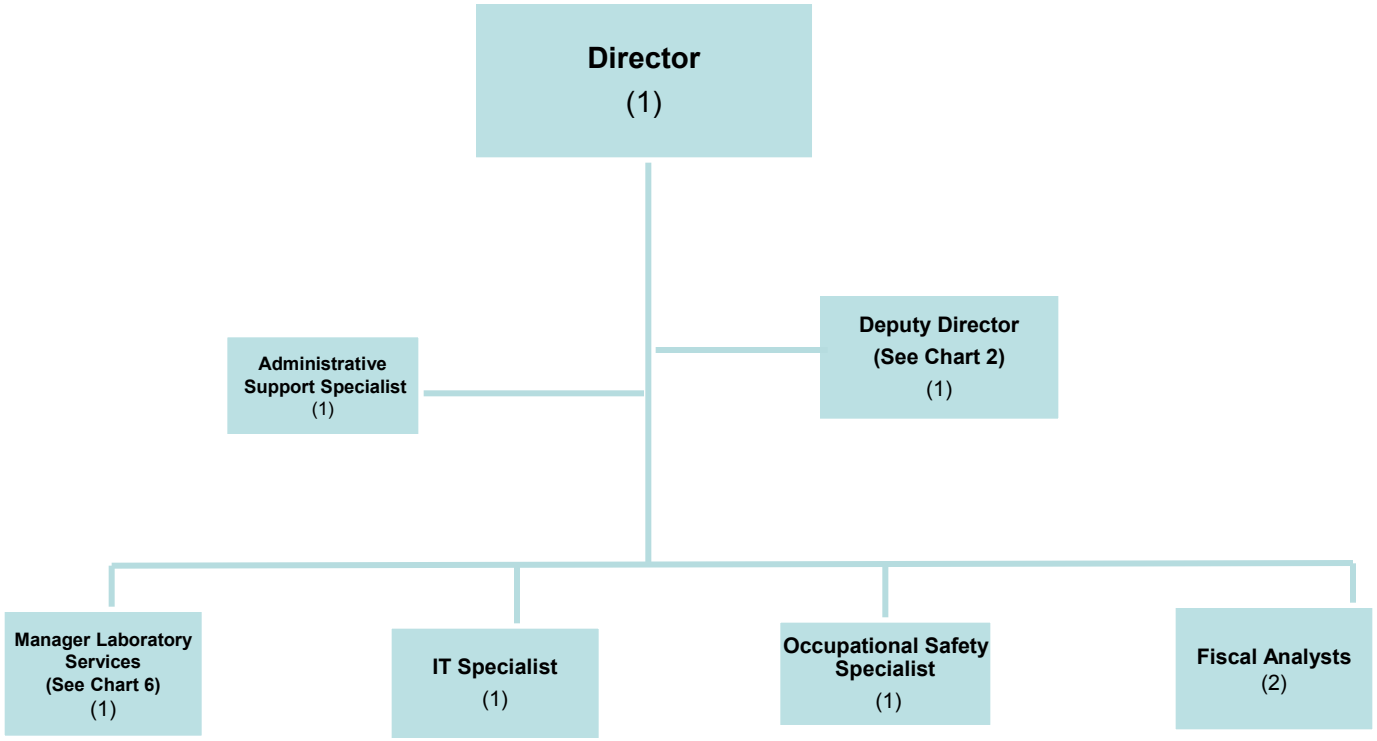
Figure 5-1
Implementation Schedule



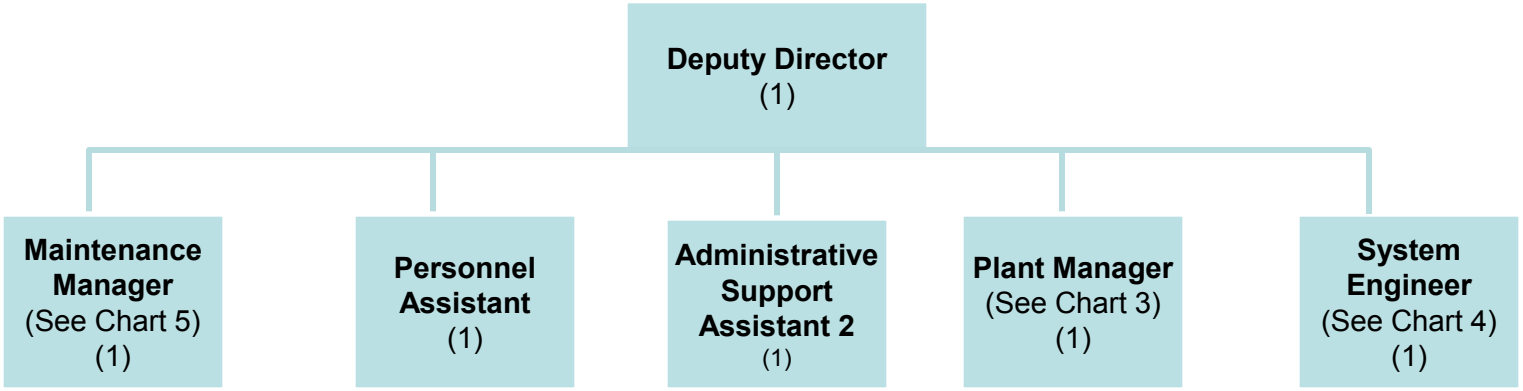
Appendix A

Waste Resources Division Organizational Chart

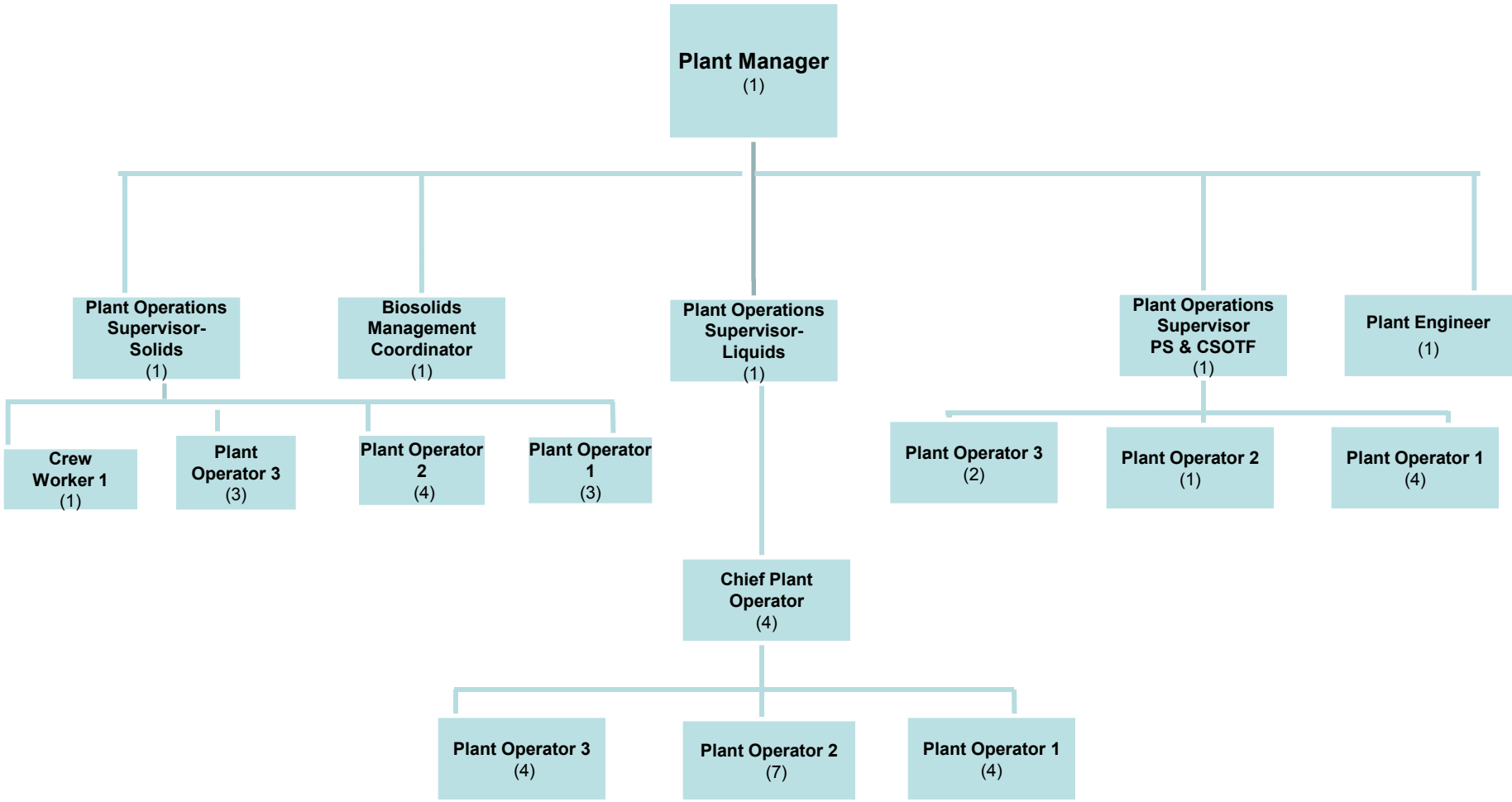
WASTE RESOURCES DIVISION
ORGANIZATIONAL CHART
(September, 2014)



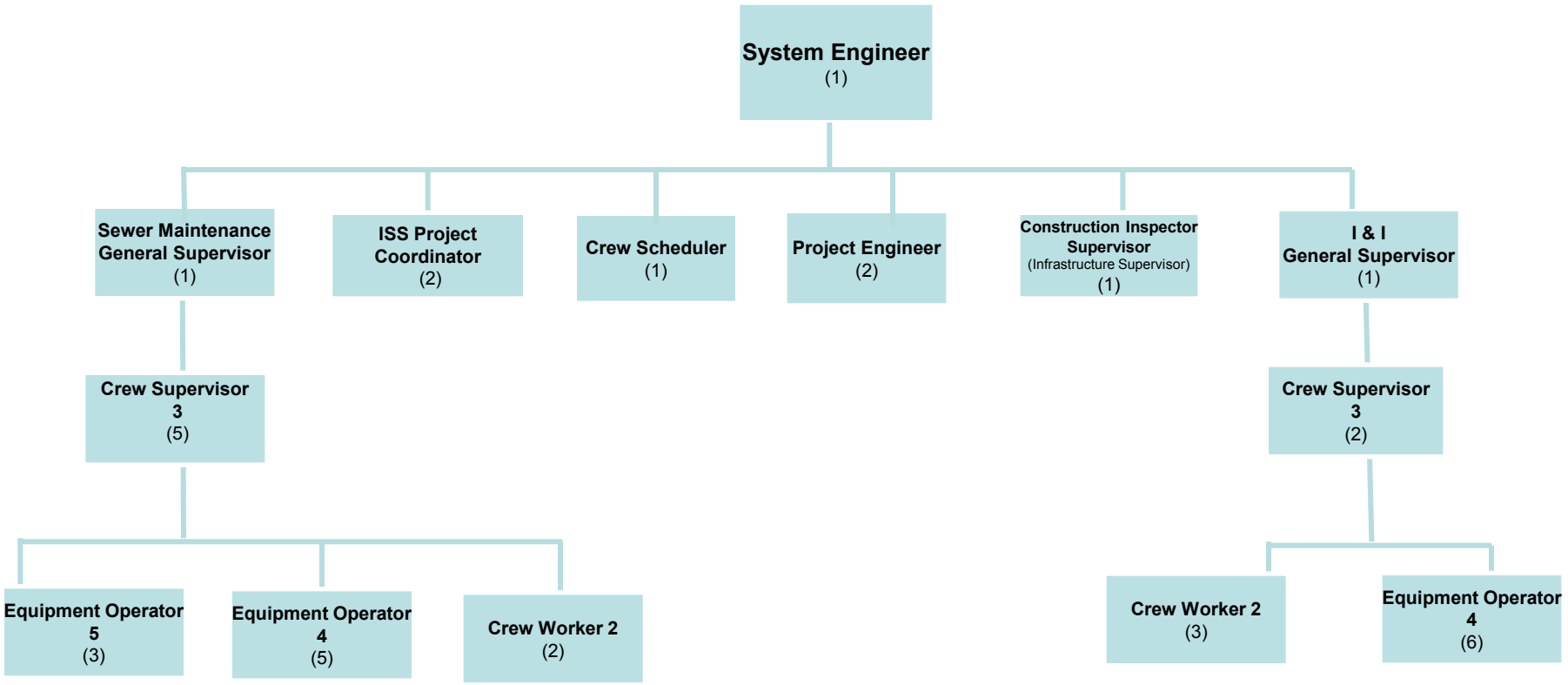
WASTE RESOURCES DIVISION
ORGANIZATIONAL CHART
Chart 2
(September, 2014)



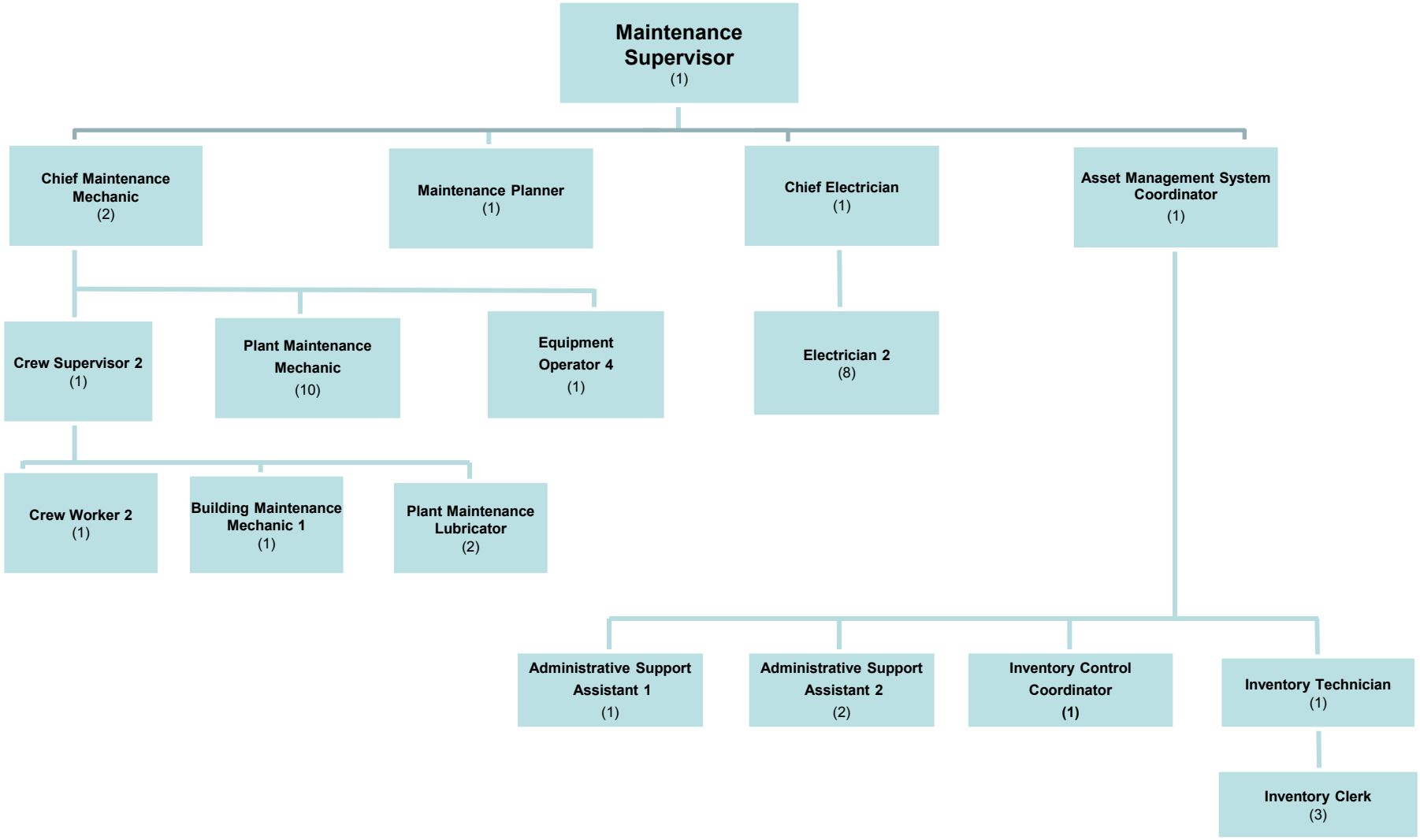
WASTE RESOURCES DIVISION
ORGANIZATIONAL CHART
Chart 3
(September, 2014)



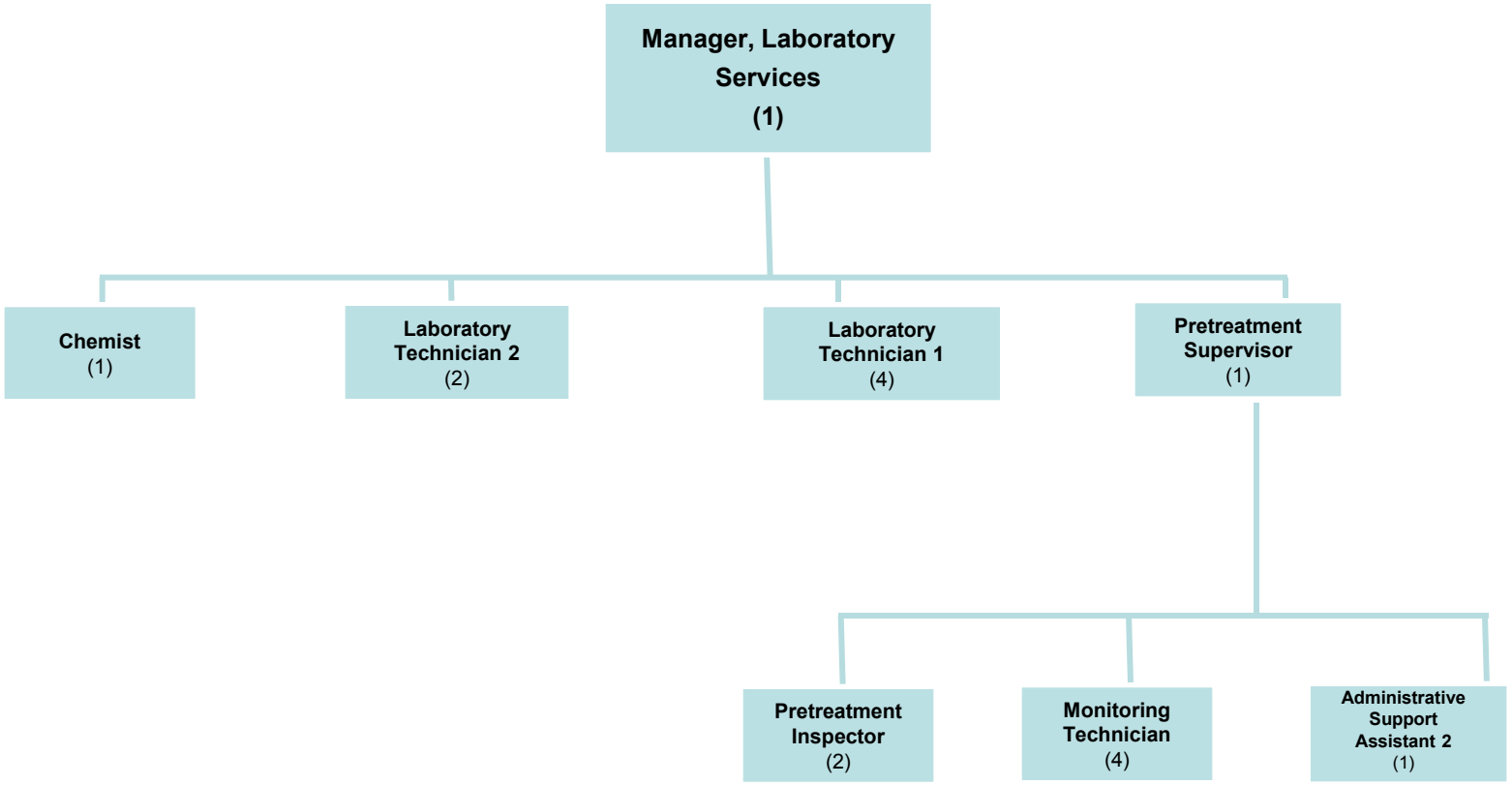
WASTE RESOURCES DIVISION
ORGANIZATIONAL CHART
Chart 4
(September, 2014)



WASTE RESOURCES DIVISION
ORGANIZATIONAL CHART
Chart 5
(September, 2014)



WASTE RESOURCES DIVISION
ORGANIZATIONAL CHART
Chart 6
(September, 2014)



Appendix B

GI Control Fact Sheets

Green Infrastructure

DESCRIPTION

Green infrastructure (GI) uses vegetation, soils, and natural processes to manage water and create healthier urban environments. This includes the range of GI controls that use plant/soil systems, permeable pavement, stormwater harvesting or reuse, or native landscaping to store, infiltrate, and/or evapotranspirate stormwater to reduce flows to the sewer systems or to surface waters.

GREEN INFRASTRUCTURE CONTROLS

- Pervious Pavement
- Infiltration Practice
- Bioretention/Rain Garden
- Vegetated Swale
- Vegetated Filter Strip
- Green Roof
- Rain Barrel/Cistern
- Disconnect Impervious Area
- Stormwater Planter
- Manufactured Device
- Naturalized Basin
- Restorative Practice

LINKS

Resource Rain – Rainwater Management Guide:
http://www.chattanooga.gov/public-works/city-engineering-a-water-quality-program/water-quality-program/resource-rain
U.S. EPA Green Infrastructure Website:
http://water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm
The Stormwater Manager's Resource Center:
http://www.stormwatercenter.net/
Low Impact Development Center:
http://www.lowimpactdevelopment.org/
International Stormwater BMP Database:
http://www.bmpdatabase.org/

BENEFITS

- Runoff Volume Reduction
- Runoff Water Quality Enhancement
- Runoff Peak Rate Reduction
- Groundwater Recharge
- Runoff Temperature Mitigation
- Heat Island Reduction
- Habitat Creation

APPLICATIONS

- Roadway
- Parking Lots
- Schools
- Parks
- Vacant Land
- Public Facilities
- Private Partnerships

SITING CONSIDERATIONS

- Land Use
- Soils/Geology
- Slopes
- Floodplains
- Water Table/Bedrock Separation
- Hot Areas

MAINTENANCE

Green Infrastructure controls require varying levels of maintenance.

Vegetated practices often require extra maintenance until they are established.

Green Infrastructure

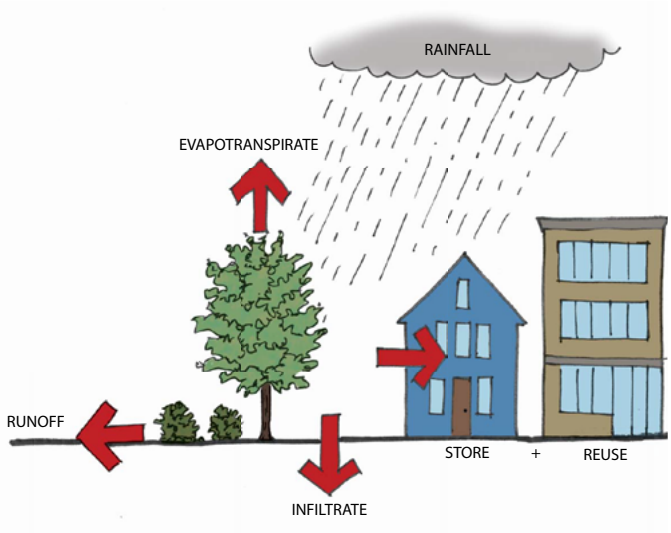
CAPITAL COST

- It is important to consider the life cycle cost of the GI control in addition to capital cost.
- Green infrastructure controls can be applied at varied scales within a wide array of site conditions which results in a wide range of costs.

VEGETATION

- Vegetation for GI controls must follow the Planting Guidelines in Protocol 5 of the Rainwater Management Guide.
- Use native or non-native plant species, but never invasive species (refer to the Tennessee Exotic Pest Plant Council).
- Consider the soil moisture conditions for the appropriate planting Zones outlined in Protocol 5 of the Rainwater Management Guide.

Green Infrastructure Functions



Performance

BMP	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation	Maintenance Burden	Cost
Pervious Pavement	●	●	●	●	●	⊙	○	○	⊙
Infiltration Practice	●	●	⊙/●	●	●	○/⊙	○	○	⊙
Bioretention/Rain Garden	○/⊙	●	⊙	○/⊙	●	⊙	●	○/⊙	○/⊙
Vegetated Swale	●	●	⊙	⊙	⊙	⊙	⊙	○	○
Vegetated Filter Strip	○	⊙	⊙	○/⊙	⊙	⊙	○	○	○
Green Roof	⊙	●	●	○/⊙	●	●	⊙	○/⊙	⊙/●
Rain Barrel/Cistern	●	●	●	○/⊙	●	○	○	⊙/●	⊙/●
Disconnect Impervious Area	●	○	●	●	●	●	○	○	⊙
Stormwater Planter	○/⊙	⊙/●	⊙/●	⊙	⊙/●	⊙/●	○/⊙	○/⊙/●	○/⊙
Manufactured Device	○/⊙	○/⊙	○/⊙	○/⊙	○/⊙	○/⊙	○/⊙	○/⊙	○/⊙
Naturalized Basin	●	●	●	●	●	●	●	○	○
Restorative Practice	⊙/●	⊙/●	⊙	⊙/●	⊙/●	○/⊙	●	○/⊙	○/⊙

Pervious Pavement

DESCRIPTION

Pervious pavement consists of a pervious (permeable) surface composed of asphalt, concrete, pavers, reinforced turf, or rubber play surface underlain by an open-graded stone storage or infiltration bed. Stormwater runoff permeates through the surface, is stored within the voids of the infiltration bed, and then slowly infiltrates into the underlying, uncompacted soils.

Pervious pavement areas are well suited for parking lots, playgrounds, plazas, pathways, and other hardscape pavement areas. Stormwater runoff from other portions of the site can be conveyed into an infiltration bed increasing storage capacity and infiltration. In locations where infiltration is not feasible or is limited, the subsurface infiltration bed can include an underdrain system for slow release.

KEY DESIGN FEATURES

- Infiltration testing required
- Maintain appropriate setbacks from structures
- Pretreatment to minimize maintenance
- Clean-washed, open-graded stone storage bed with minimum of 40 percent void space
- Nonwoven geotextile at soil/stone interface
- Surface and stone bed must be designed for anticipated traffic loads
- Level, uncompacted subgrade
- Secondary inflow mechanism as backup if pavement clogs
- Include a positive overflow

APPLICATIONS

- Roadway (low volume, parking lanes)
- Parking lots
- Parks (walkways, playgrounds, plazas, terraces, ball courts)
- Public Facilities (sidewalks, parking areas)
- Schools (playgrounds, ball courts, parking areas)
- Private Partnerships

ADVANTAGES

- Provides volume reduction and peak rate reduction
- Provides regional stormwater management
- Stormwater management incorporated into hardscape
- Effective in contaminant reduction
- Can be benched or terraced to accommodate slopes
- Withstands freeze-thaw cycles
- Lifespan comparable to traditional pavements

DISADVANTAGES

- High clogging potential
- Higher maintenance requirements with new technologies
- Setback considerations
- Not applicable with high bedrock, high groundwater, or contaminated soils.
- Infiltration requires suitable site conditions

VARIATIONS

- Pervious Asphalt
- Pervious Concrete
- Pervious Concrete Pavers
- Brick Pavers
- Reinforced Turf or Gravel
- Pervious Rubber and Manufactured Pervious Mixes

Pervious Pavement

SITING

Soils: HSG A & B preferred; HSG C & D may require underdrains
Slopes: Low feasibility on steep slopes (<6%)
Floodplain: Not Acceptable
Water Table/Bedrock Separation: 2-foot minimum, 4-foot recommended
Hot Areas: Pretreatment system/impervious liner

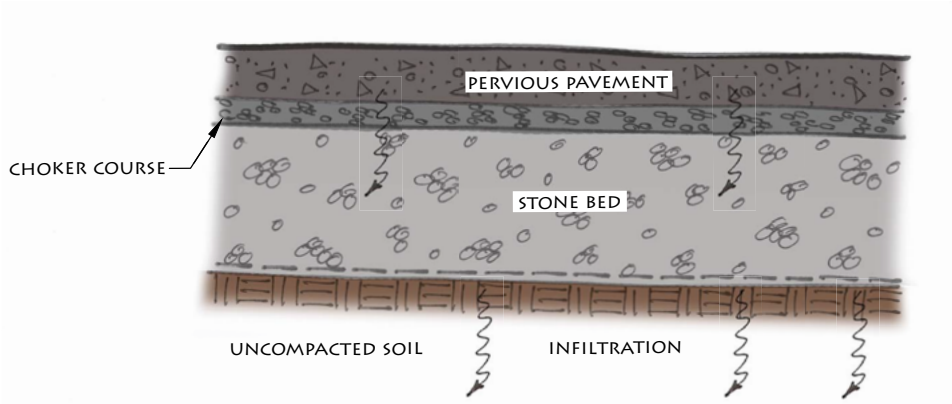
MAINTENANCE

- Vacuum twice per year
- Remove trash and debris as needed
- Refrain from pressure washing

CAPITAL COST

- Varies by type and installation
- $7-$15 per square foot
- Cost effective when compared on marginal basis

Pervious Pavement Cross-Section



LINKS

Resource Rain – Rainwater Management Guide:
http://www.chattanooga.gov/images/citymedia/publicworks/WQ/ResourceRain/Manual/5.3.1_Pervious_Pavement.pdf

U.S. EPA – Permeable Pavements:
http://water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm#permeablepavements
National Ready Mix Concrete Association: http://www.perviouspavement.org/

Performance

BMP	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation
Pervious Pavement	●	●	●	●	●	◉	○

Infiltration Practice

DESCRIPTION

Infiltration practices are a collection of stormwater management techniques in which the entire design capture volume infiltrates to the soil and percolates to shallow aquifers from which it flows to streams as interflow. Water is also removed by plants via evapotranspiration.

KEY DESIGN FEATURES

- Pretreatment to prevent clogging
- Include positive overflow
- Clean-washed, open-graded stone storage bed with minimum of 40 percent void space
- Level, uncompacted subgrade
- Nonwoven geotextile at soil/stone interface, including top of bed to prevent soil movement into stormwater bed
- Conveyance components

INFILTRATION BED

An infiltration bed captures and temporarily stores stormwater runoff in a media bed that is located beneath an impervious surface or beneath an engineered layer of soil and vegetation.

INFILTRATION TRENCH

An infiltration trench consists of a linear trench of open-graded aggregate or media that can capture, hold, and infiltrate stormwater. Its functions are similar to a stormwater infiltration bed except that it may also serve as part of a conveyance system, especially during larger storm events.

APPLICATIONS

- Roadway (shoulders, medians, cul-de-sacs)
- Parking Lots (subsurface, islands, edges)
- Schools
- Parks
- Vacant Land
- Public Facilities
- Private Partnerships

ADVANTAGES

- Provides volume reduction and peak rate reduction
- Provides regional stormwater management
- Maintains use of the space (active recreation/parking)
- Effective for maintaining soil moisture conditions
- Flexible dimensions to fit conditions
- Excellent retrofit capability
- Can be benched or terraced to accommodate slopes

DISADVANTAGES

- High clogging potential
- Not visible (maintenance, education, asset management)
- Setback considerations
- Infiltration requires suitable soils

Infiltration Practice

SITING

Soils: HSG A & B preferred; HSG C & D may require underdrains

Slopes: Max slope 20% (benching required)

Floodplain: Outside floodplain areas

Water Table/Bedrock Separation: 2-foot minimum, 4-foot recommended

Hot Areas: Pretreatment system/impervious liner

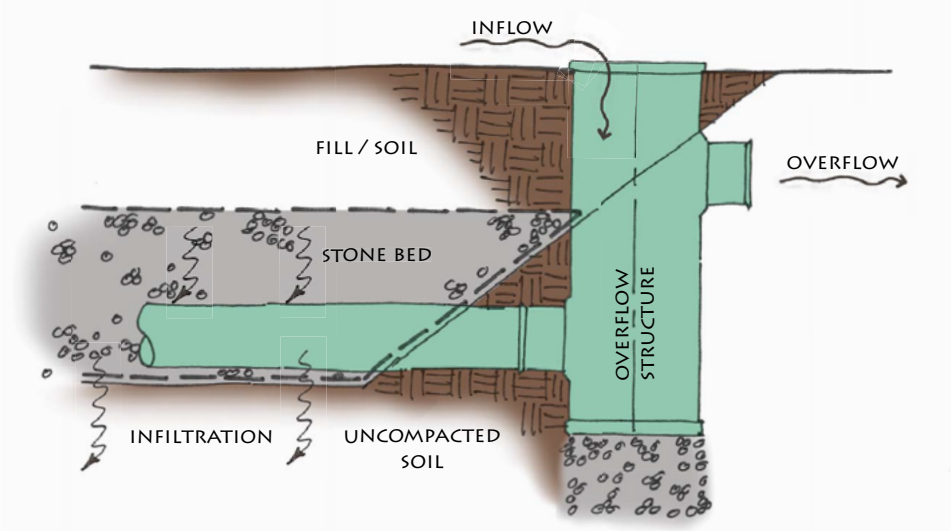
MAINTENANCE

- Inspect water quality inserts frequently
- Remove trash and debris as needed

CAPITAL COST

- Infiltration Bed: $13 per cubic foot
- Infiltration Trench: $20-$30 per cubic foot
- Dry Well: $4-$9 per cubic foot
- Stormwater Drainage Well: Dependent upon depth

Infiltration Bed and Overflow Structure



LINKS

Resource Rain – Rainwater Management Guide:

http://www.chattanooga.gov/images/citymedia/publicworks/WQ/ResourceRain/Manual/5.3.2_Infiltration_Bed.pdf

The Stromwater Manager's Resource Center:
http://www.stormwatercenter.net/

Performance

BMP	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation
Infiltration Bed	●	●	●	●	●	○	○
Infiltration Trench	●	●	⊙	●	●	⊙	○
Dry Well	⊙	○/⊙	⊙	●	●	○	○
Stormwater Drainage Well	⊙	⊙/●	⊙	●	●	○	○

Bioretention/Rain Gardens

DESCRIPTION

Bioretention areas are vegetated, shallow surface depressions that use the interaction of plants, soil, and microorganisms to store and treat stormwater runoff. Small bioretention areas are often referred to as rain gardens. Bioretention areas designed for infiltration can also be referred to as bioinfiltration areas, while those that cannot infiltrate and must discharge via an underdrain are sometimes referred to as bio-filtration areas.

Bioretention areas are generally flat and include engineered or modified soils that allow drainage of stormwater through soils. Plants are a critical component of bioretention and improve the soil structure and porosity through the establishment of root systems and microbial communities. Water that has drained through a bioretention area may infiltrate into the subsoil or discharge at a controlled flow rate through an underdrain system (or a combination of both).

KEY DESIGN FEATURES

- Limit depth and duration of ponded of water
- Surface area and size are directly correlated to the contributing drainage area characteristics
- Soil and stone storage depth
- Include positive overflow
- Low-flow, slow-release system where infiltration is not feasible
- Obtain appropriate soil mixture
- Native plant selection

APPLICATIONS

- Roadway (shoulders, medians, and cul-de-sacs)
- Parking lots (islands and edges)
- Public Facilities
- Parks
- Vacant Land
- Private Partnerships

ADVANTAGES

- Improves water quality
- Integrates stormwater into the landscape
- Improves aesthetics
- Flexible dimensions to fit conditions
- Creates habitat
- Excellent retrofit capability

DISADVANTAGES

- Manages small storms and "first" portion of large storms
- Steep slopes may require larger footprint to create level grading
- Vegetation and soils must be protected from damage and compaction
- Infiltration requires suitable site conditions
- Salt use may impact vegetation and soils
- Maintenance is required to maintain both performance and aesthetics

VARIATIONS

- Bioretention Cell
- Bioretention Swale
- Rain Gardens
- Bioinfiltration Basin
- Biofiltration Basin

Bioretention/Rain Gardens

SITING

Soils: HSG A and B preferred HSG; C and D may require an underdrain

Slopes: Max slope 20%

Floodplain: Acceptable

Water Table/Bedrock Separation: 2-foot minimum, 4-foot recommended

Hot Areas: Pretreatment and/or impervious liner

MAINTENANCE

- Irrigation (frequent in early stages, as needed after establishment)
- Inspect for trash and debris monthly
- Weeding, pruning, and repairs twice per year
- Inspect for ponded water
- Generally, treat as traditional landscaping

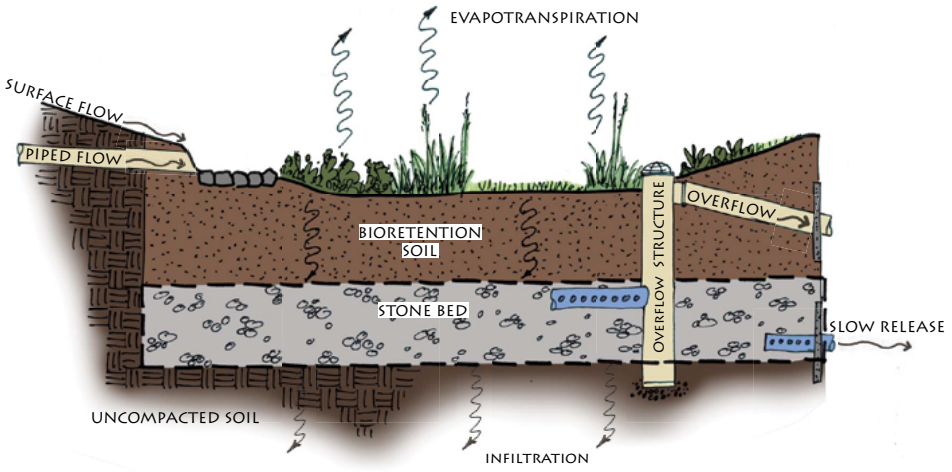
CAPITAL COST

- $10-$17 per square foot
- Varies upon types of vegetation

VEGETATION

- Comply with Planting Guidelines in Protocol 5 of the Rainwater Management Guide.
- Select plants suitable for soil moisture conditions Zones 1-3

Bioretention Cross-Section



LINKS

Resource Rain – Rainwater Management Guide: http://www.chattanooga.gov/images/citymedia/publicworks/WQ/ResourceRain/Manual/5.3.4_Bioretention.pdf

N.C. State University: http://www.bae.ncsu.edu/topic/bioretention/

U.S. EPA: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=72

Performance

BMP	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation
Bioretention/Rain Garden	○/◉	●	◉	○/◉	●	◉	○

Table Key ○=Low ◉=Medium ●=High

Vegetated Swale

DESCRIPTION

A vegetated swale is a landscaped channel, often broad and shallow with trapezoidal or parabolic geometry and a slight longitudinal slope, used to convey and treat stormwater runoff. Vegetated swales are densely planted with grasses, shrubs, and often trees, and can be used to improve water quality and reduce flow rates. Vegetated swales are a commonly used as pretreatment devices in a "treatment train" approach to improve water quality. If the swale includes berms or check dams such that water is retained and allowed to infiltrate, a vegetated swale can provide volume management.

KEY DESIGN FEATURES

- Convey 10-year/24-hour storm flow rate at non-erosive velocities
- Side slopes: 3:1 to 4:1 (H:V)
- Longitudinal slope at 2 percent maximum; up to 8 percent with check dams
- Overall depth from top of sidewalls to bottom
- Planted in grasses and shrubs, and may include trees
- Minimum vegetation height of 4 inches is recommended
- Temporary or permanent stabilization fabrics or materials is recommended
- May include berms and check dams to facilitate shallow ponding for volume reduction

APPLICATIONS

- Roadway (shoulders and medians)
- Parking lots (islands and edges)
- Schools
- Parks
- Vacant land
- Public Facilities
- Private Partnerships

ADVANTAGES

- Improves water quality and reduces flow velocities
- Integrates stormwater into landscape
- Improves aesthetics
- Flexible dimensions to fit conditions
- Reduces temperature impacts from impervious surfaces
- Excellent retrofit capability

DISADVANTAGES

- Possible erosion problems if not properly designed, constructed, and maintained
- Limited flow velocities
- Limited drainage areas
- Not appropriate for project sites where spills may occur
- Maintain and protect vegetation and soils from compaction
- Salt use may impact vegetation and soils

VARIATIONS

- Drainage Swale
- Bioswale
- Vegetated Swale with Infiltration Trench
- Vegetated Swale with Check Dams

Vegetated Swale

SITING

Soils: A&B preferred, C&D may require an underdrain

Slopes: 8% max slope

Floodplain: Acceptable

Water Table/Bedrock Separation: 2-foot minimum, 4-foot recommended

Hot Areas: Not Acceptable

MAINTENANCE

- Weeding and pruning may be necessary until vegetation is established
- Mowing schedule depends on variety of vegetation
- Inspect annually for sediment buildup, erosion, vegetative conditions, etc.

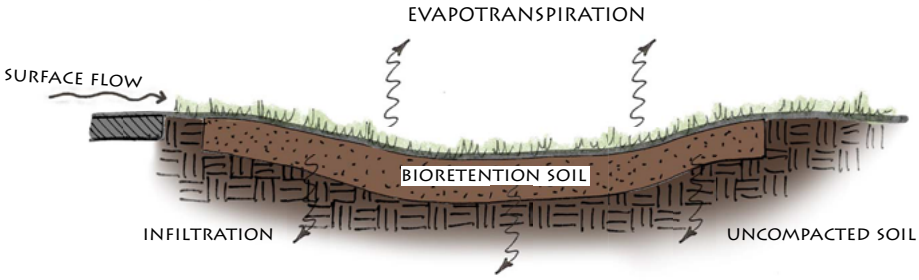
CAPITAL COST

- $5-$20 per linear foot
- Dependent upon extent of grading and vegetation

VEGETATION

- Comply with Planting Guidelines in Protocol 5 of the Rainwater Management Guide.

Vegetated Swale Cross-Section



LINKS

Resource Rain – Rainwater Management Guide:
http://www.chattanooga.gov/images/citymedia/publicworks/WQ/ResourceRain/Manual/5.3.5_Vegetated_Swales.pdf

U.S. EPA:
http://water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm#bioswales

Low Impact Development Center:
http://www.lowimpactdevelopment.org/ffxcty/2-7_waterqualityswale_draft.pdf

Performance

BMP	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation
Vegitated Swale	●	●	◉	◉	◉	◉	◉

Table Key ○=Low ◉=Medium ●=High

Vegetated Filter Strip

DESCRIPTION

Vegetated filter strips are permanent areas of dense vegetation located between runoff pollutant sources (such as parking lots) and other stormwater controls or receiving water bodies. Vegetated filter strips may be constructed of turf, meadow grasses, or other vegetation such as landscape plantings. Vegetated filter strips act as pretreatment devices in a "treatment train" which impede the velocity of stormwater runoff (thereby allowing sediment to settle out), reduce the impacts of temperature, and encourage infiltration. Thus, vegetated filter strips can be a useful control to slow the rate of runoff and reduce peak flows.

KEY DESIGN FEATURES

- Runoff sheet flows across vegetation to avoid channelization
- Capture areas should be small and localized
- Target slope of 2 to 5 percent
- Minimum 25 feet length in the direction of flow (shorter lengths provide some water quality benefits adjacent to other BMPs)
- Concentrated flow should not be discharged directly onto a filter strip

APPLICATIONS

- Roadway (shoulders and medians)
- Parking lots (edges)
- Schools
- Parks
- Vacant Land
- Public Facilities
- Private Partnerships

ADVANTAGES

- Integrates stormwater into landscape
- Improves aesthetics
- Flexible dimensions to fit conditions
- Creates habitat for wildlife
- Excellent retrofit capability

DISADVANTAGES

- Volume reduction not quantifiable
- Maintenance must be clearly defined to avoid mowing
- Vegetation and soils must be protected from damage and compaction
- Salt use may impact vegetation and soils
- Vegetation must be firmly established and densely spaced, to avoid potential for erosion

Vegetated Filter Strip

SITING

Soils: Any

Slopes: less than 5% contributing area, 2-5% for BMP

Floodplain: Acceptable

Water Table/Bedrock Separation: Any

Hot Areas: Not Acceptable

MAINTENANCE

- Maintain 4" minimum vegetation height
- Weeding and pruning may be necessary until vegetation is established
- Inspect annually for sediment buildup, erosion, vegetative conditions, etc.

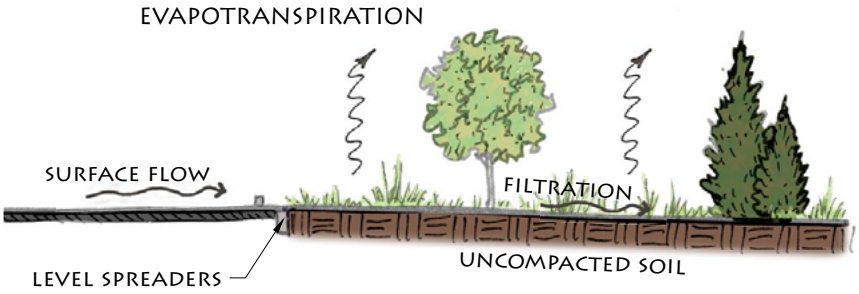
CAPITAL COST

- Minimal cost, mainly vegetation
- Grading may or may not be necessary

VEGETATION

- Comply with Planting Guidelines in Protocol 5 of the Rainwater Management Guide.

Vegetated Filter Strip Cross-Section



LINKS

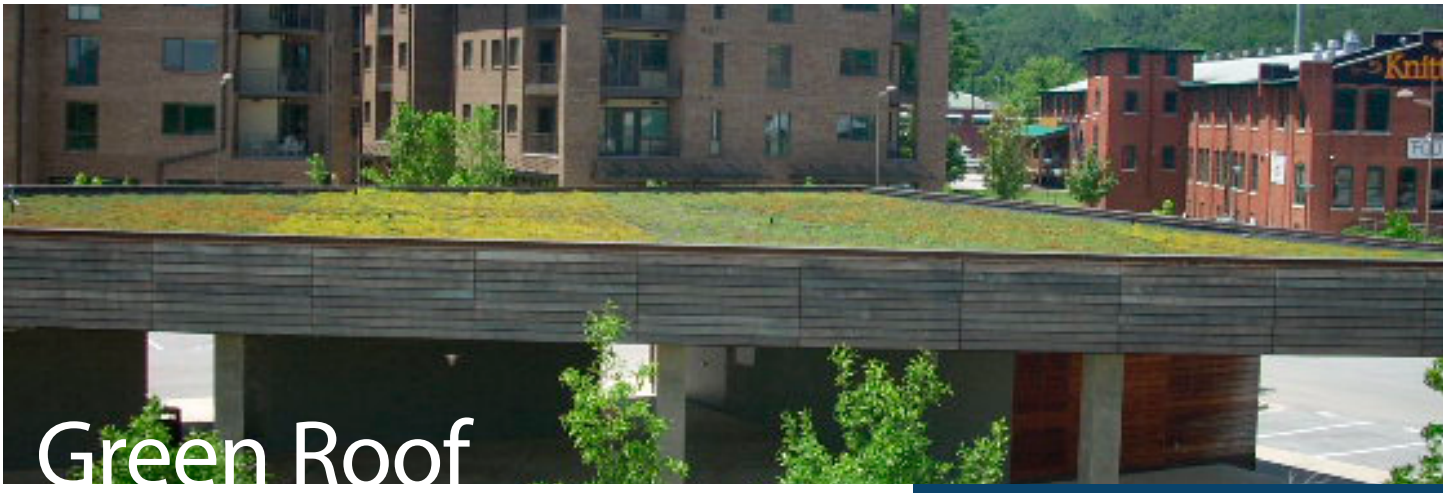
Resource Rain – Rainwater Management Guide:
http://www.chattanooga.gov/images/citymedia/publicworks/WQ/ResourceRain/Manual/5.3.6_Vegetated_Filter_Strips.pdf

The Stormwater Manager's Resource Center:
http://www.stormwatercenter.net/

Performance

BMP	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation
Vegetated Filter Strip	○	◉	◉	○ / ◉	◉	◉	○

Table Key ○=Low ◉=Medium ●=High



Green Roof

DESCRIPTION

A green roof (also referred to as a vegetated roof or living roof) consists of vegetated roof cover used to mimic the hydrologic performance of surface vegetation rather than the impervious surface cover of a flat or pitched roof. Green roofs may be designed to meet a variety of goals and conditions including reduction in runoff volume, reduction in runoff flow rate, and improvements in water quality.

Green roofs may be extensive systems, intensive systems or somewhere in between. Extensive systems are lightweight, lower in cost, and lower in maintenance. Intensive systems are more complex green roof designs which incorporate deeper soils to promote and sustain larger planting structures and integrate human occupancy of roof space.

In addition to stormwater benefits, green roofs can provide direct benefits in terms of increased longevity of the roofing system (by protecting the roof from temperature extremes) and insulation benefits that may reduce heating or air-conditioning energy costs.

KEY DESIGN FEATURES

- Engineered growing media with high mineral content
- One or more drainage layers
- Engineered media for extensive vegetated roof covers is typically 85 percent to 97 percent non-organic
- Vegetated roof covers intended to achieve water quality benefits should not be fertilized
- Anticipate the need to manage large rainfall events without inundating the cover
- Roofs with pitches steeper than 2:12 must incorporate stability measures
- May include a wind erosion stabilization system

APPLICATIONS

- Roadways (bus stops)
- Schools
- Parks (buildings)
- Public Facilities (buildings)
- Private Partnerships (buildings)

ADVANTAGES

- Appropriately designed green roofs can manage quantity, improve quality, and reduce the rate of stormwater runoff
- Heating and cooling energy savings
- Sound-absorbing benefits to the building and surroundings
- Mitigate urban heat island effects and reduce atmospheric levels of greenhouse gases
- Provide habitat

DISADVANTAGES

- May be more expensive to design and construct than other BMPs
- Retrofit applications may require structural modifications to the building
- Maintenance for green roofs may require weeding and watering until vegetation is established

Green Roof

SITING

Soils: Any

Slopes: Any

Floodplain: Acceptable

Water Table/Bedrock Separation: Any

Hot Areas: Acceptable

VARIATIONS

- Intensive/Extensive
- Single/Dual Media
- Blue Roof

MAINTENANCE

- Weeding and watering frequently until vegetation is established
- Inspection and removal of trash and debris frequent if human occupancy is integrated into green roof
- Maintenance costs similar to traditional landscaping

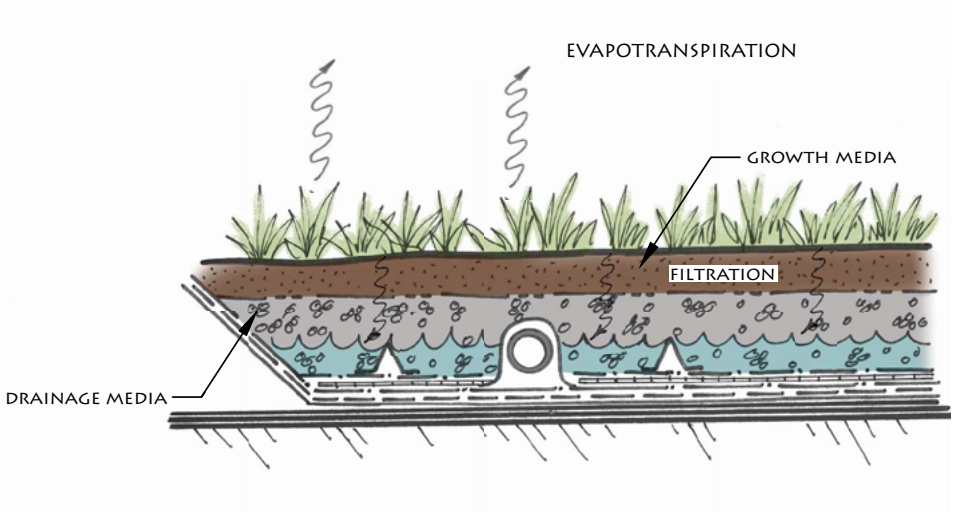
CAPITAL COST

- $5-$50 per square foot
- Varies greatly in selection of extensive vs. intensive systems and in retrofit applications

VEGETATION

- Comply with Planting Guidelines in Protocol 5 of the Rainwater Management Guide.

Green Roof Cross-Section



LINKS

Resource Rain – Rainwater Management Guide:
http://www.chattanooga.gov/images/citymedia/publicworks/WQ/ResourceRain/Manual/5.3.8_Green_Roofs.pdf

Green Roofs for Healthy Cities:
http://www.greenroofs.org/

U.S. EPA:
http://water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm#greenroofs

Performance

BMP	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation
Green Roof	◉	●	●	○ / ◉	●	●	◉

Table Key ○=Low ◉=Medium ●=High

Rain Barrel/Cistern

DESCRIPTION

Rain barrels/cisterns capture and reuse stormwater. The collected runoff can be used as a resource when it is captured from rooftops and other impervious surfaces. Captured rainwater can be used for landscape irrigation, vehicle washing, street cleaning, and, depending upon local plumbing codes, toilet flushing. Roof runoff is generally cleaner and more suitable than runoff from parking lots and roads, which require additional treatment and maintenance to address sediment, oils and grease. Air conditioning condensate (although not part of runoff) can also be captured in cisterns for reuse instead of being discharged to the combined sewer system. Rain barrels/cisterns may reduce the volume and peak flows associated with stormwater runoff in highly urbanized areas where infiltration practices aren't feasible.

KEY DESIGN FEATURES

- Contributing areas must be evaluated for potential pollutants including metals, fungicides, and herbicides
- Roofs should not include copper or be treated with fungicides or herbicides
- Store the appropriate runoff volume from the contributing capture area
- Reuse needs should be adequate to drain the cistern within defined time frame or provide dewatering mechanism
- Backup water supply if intended for grey water use
- Emergency overflow for large storm events
- Cisterns must be watertight, vented, completely covered or screened, composed of non-reactive materials, and be approved for potable water storage
- Screens or other cover is necessary to prevent mosquito breeding if open to the air
- Spigots or hose bibs at above-grade cisterns should be labeled "NON-POTABLE" and be equipped with an atmospheric vacuum breaker
- Safety labels should be placed on cisterns stating "NON-POTABLE" and "DROWNING HAZARD"
- Backflow preventers must be installed on water service lines from cisterns
- Storage tanks should be placed in cool, shaded areas to help prevent the growth of algae

APPLICATIONS

- Schools
- Parks (buildings)
- Public Facilities
- Private Partnerships

ADVANTAGES

- Provides volume reduction
- Contributes to peak rate reduction
- Reduces potable water needed for irrigation, toilet flushing, or other applications
- Visible cisterns increase public awareness

DISADVANTAGES

- Water held within a cistern must be emptied between storms to provide volume reduction for the next storm
- Treatment of water for reuse may be necessary depending on the contaminant in the contributing drainage area
- Reusing runoff for potable uses is not recommended in the U.S., unless water is treated to all required water quality standards
- Pumps may be required

VARIATIONS

- Residential rain barrels
- Rainwater harvesting systems
- Above ground, underground, and indoor
- Modular units
- Tanks

Rain Barrel/Cistern

SITING

Soils: Any
Slope: Any
Floodplain: Acceptable
Water Table/Bedrock Separation: Any (although may hinder installation of subsurface systems)
Hot Areas: Acceptable (may require treatment depending on the pollution source)

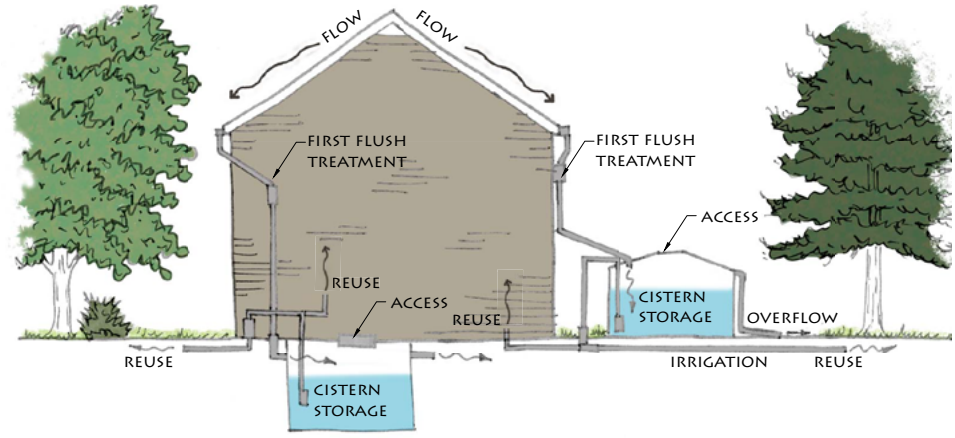
MAINTENANCE

- Emptying before the next storm event (some proprietary systems automate process)
- Inspect twice per year to insure operable and no leaks
- Clean tanks and check backflow preventers annually
- Depends upon mechanical systems for additional needs

CAPITAL COST

- Rain Barrels: $100-$300
- Cisterns: $500-$5,0000
- Rainwater Harvesting Systems: $30,000-$100,000 (pretreatment, cistern, and mechanical systems)

Cistern Storage and Reuse Schematic



VEGETATION

- Comply with Planting Guidelines in Protocol 5 of the Rainwater Management Guide.
- When located along streets, plant selection must consider visibility for traffic needs.

LINKS

Resource Rain – Rainwater Management Guide:
http://www.chattanooga.gov/images/citymedia/publicworks/WQ/ResourceRain/Manual/5.3.9_Runoff_Capture-Reuse.pdf

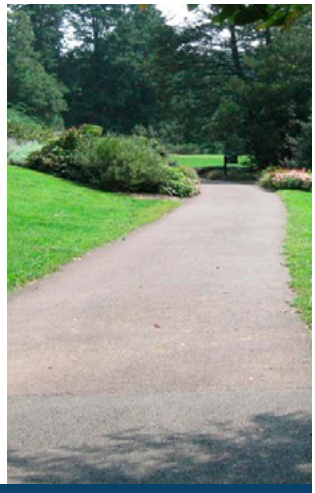
American Rainwater Catchment Systems Association:
http://www.arcsa.org/

U.S. EPA:
http://water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm#rainwaterharvesting

Performance

BMP	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation
Rain Barrel/Cistern	●	●	●	○ / ◉	●	○	○

Table Key ○=Low ◉=Medium ●=High



Disconnect Impervious Area

DESCRIPTION

The disconnection of impervious areas can be achieved by directing runoff from roof leaders, roads, driveways, and other paved surfaces toward vegetated areas rather than conveying runoff to the combined sewer system. The disconnection of impervious areas can be achieved by directing runoff from roof downspouts, roads, driveways, and other paved surfaces toward vegetated areas rather than conveying runoff to the CSS. Impervious area disconnections can be a low-cost retrofit, or can reduce piping costs on new construction projects. The GI control can also reduce erosion at the outlets of stormwater drainage systems by dispersing runoff near the source.

KEY DESIGN FEATURES

- Disperse runoff at the source onto a sufficiently sized vegetated area
- Grade vegetated area (<5%) to promote overland sheet flow away from all structures
- Ensure disconnection avoids basement seepage and compromising building foundations
- Use of splash block or other energy dissipation devices
- Disconnect areas are encouraged with permeable soils or BMPs
- Runoff cannot come from a designated hotspot area

APPLICATIONS

- Roadway (medians, curb & gutter removal)
- Parking Lots (curb cuts)
- Schools (downspout disconnection)
- Public Facilities (downspout disconnection)
- Private Partnerships (downspout disconnection)

ADVANTAGES

- Directly removes stormwater from combined sewer system
- Reduces the volume and peak rate
- Pollutants are captured and retained by filtering through plants and soil
- Low-cost retrofit or can provide cost savings on new projects

DISADVANTAGES

- Improper design has the potential to cause basement seepage, yard ponding, or erosion
- Specific site characteristics including land use, soil, and topography influence implementation
- Requires nearby areas to be designed to receive stormwater runoff
- Not as applicable in densely developed areas

VARIATIONS

- Disconnection of Roof Leaders
- Disconnection of Paths
- Disconnection of Parking Lots

Disconnect Impervious Area

SITING

Soils: HSG A & B or adjacent to BMP

Slopes: <5% grade for receiving vegetated areas

Floodplain: Acceptable

Water Table/Bedrock Separation: Any

Hotspots: Not Acceptable

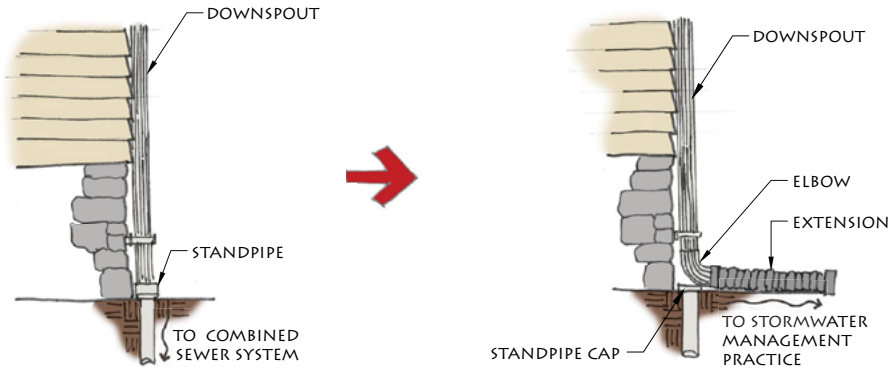
MAINTENANCE

- See Vegetated Filter Strip for vegetated areas
- Inspect points of discharge for blockage, scour, ponding, and erosion frequently

CAPITAL COST

- Inexpensive retrofits ($100-$500)

Downspout Disconnection Schematic



LINKS

Resource Rain – Rainwater Management Guide:
http://www.chattanooga.gov/images/citymedia/publicworks/WQ/ResourceRain/Manual/5.3.10_Disconnected_Impervious_Areas.pdf

U.S. EPA:
http://water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm#downspout

Performance

BMP	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation
Disconnect Impervious Area	●	○	●	●	●	●	○

Table Key ○=Low ◉=Medium ●=High

Stormwater Planter

DESCRIPTION

Stormwater planters are structures, either elevated or at ground level, which are filled with bioretention soils and plants to capture, detain, and filter stormwater runoff through physical, biological, and chemical processes. Planters are commonly constructed of concrete, concrete masonry units, or brick. They can be placed adjacent to the external downspouts of a building to receive rooftop runoff or along streets to receive runoff from impervious surfaces such as sidewalks or roadways. Planters can be designed as flow-through (or contained) planters which could direct runoff back into the combined sewer system or infiltration planters which infiltrate stormwater runoff into native soils or an infiltration bed.

STORMWATER PLANTER BOX

Stormwater planter boxes contain bioretention soils and typically short growth plants with a shallow root system. They may be designed with open bottoms to infiltrate water or with an impervious bottom discharging to the sewer system. Temporary surface ponding detains stormwater to allow percolation through the soil media.

TREE TRENCH

Tree trenches are stormwater planters that require a more substantial structure in order to house a healthy root system. Tree trenches provide additional benefits such as tree canopy and air quality improvements.

STORMWATER CURB EXTENSION

Stormwater curb extensions are a specific type of planter that can be incorporated into a street scape to assist with traffic calming or defining parking areas.

KEY DESIGN FEATURES

- Appropriately sized systems for capturing small (1.6 inches and less) rainfall events
- Surface ponding 6”-12” max
- Level subgrade
- Inflow velocities and energy dissipation devices
- Setbacks from structures
- Include a low-flow slow-release system where infiltration is not feasible
- Include an overflow control structure to allow bypass for large storms
- Native plants
- Adequate root depth and tree spacing where applicable
- Overhead clearance

APPLICATIONS

- Roadway (medians, curbs)
- Parking Lots (islands)
- Schools
- Parks
- Public Facilities

ADVANTAGES

- Urban, high-density residential and commercial sites
- Regional stormwater management applications
- Improves aesthetics
- Well suited for retrofit projects
- Applicable to small drainage areas
- Provides water quality treatment within a small footprint

DISADVANTAGES

- Can be maintenance intensive
- Subject to vandalism and/or accumulated trash/debris
- Highly structural nature may be cost-prohibitive in certain applications

Stormwater Planter

SITING

Soils: Any for contained and flow-through; HSG A and B preferred for infiltration

Slopes: <5%

Floodplain: Acceptable for flow-through, Not Acceptable for infiltration

Water Table/Bedrock Separation: 2-foot minimum, 4-foot recommended

Hot Areas: Acceptable for flow-through; Not Acceptable for infiltration

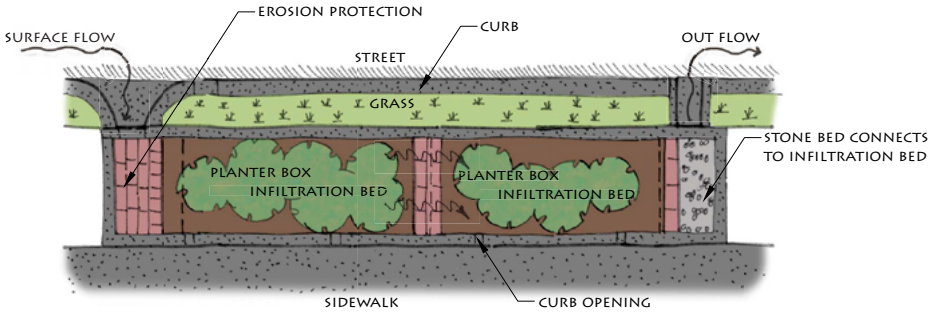
MAINTENANCE

- Removal of trash/debris frequently
- Inspections for scour, erosion, washouts, ponding, vegetative conditions

COST

- $850 per tree
- $10-$15 per square ft
- $8,000-$10,000 to purchase one prefabricated tree pit system including filter material, plants, and some maintenance; $1,500-$6,000 for installation

Stormwater Planter Schematic (Plan View)



LINKS

Resource Rain – Rainwater Management Guide:
http://www.chattanooga.gov/images/citymedia/publicworks/WQ/ResourceRain/Manual/5.3.11_Stormwater_Planter_Box.pdf

U.S. EPA:
http://water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm#planterboxes

Low Impact Development Center:
http://www.lowimpactdevelopment.org/ffxcty/1-6_treebox_draft.pdf

Performance

BMP	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation
Stormwater Planter Box	●	⊙	●	⊙	●	⊙	○
Tree Trench	⊙	⊙ / ●	⊙	⊙	⊙	●	⊙
Stormwater Curb Extension	⊙	⊙ / ●	⊙	⊙	⊙ / ●	●	○

Table Key ○=Low ⊙=Medium ●=High

Manufactured Device

DESCRIPTION

Manufactured devices are pre-fabricated devices that implement technologies ranging from filtration and adsorption to vortex separation and settling to treat stormwater runoff. Treatment may be necessary downstream of areas where excessive pollutants, such as oil and grease, discharge to a stream, to the CSS, or to other GI controls. Common types of manufactured devices include hydrodynamic devices, catch basin inserts, cartridge filters, and biotreatment devices. Manufactured devices provide stormwater treatment with varying degrees of effectiveness.

KEY DESIGN FEATURES

- Hydraulic flow capacity of each manufactured device must match that of design storm event flows to achieve desired performance
- Treatment train component
- Manufacturer installation, operation, and maintenance instructions

APPLICATIONS

- Roadway (inlets, drainage network)
- Parking Lots (industrial/commercial)
- Public Facilities (industrial/commercial)
- Private Partnerships (industrial/commercia

ADVANTAGES

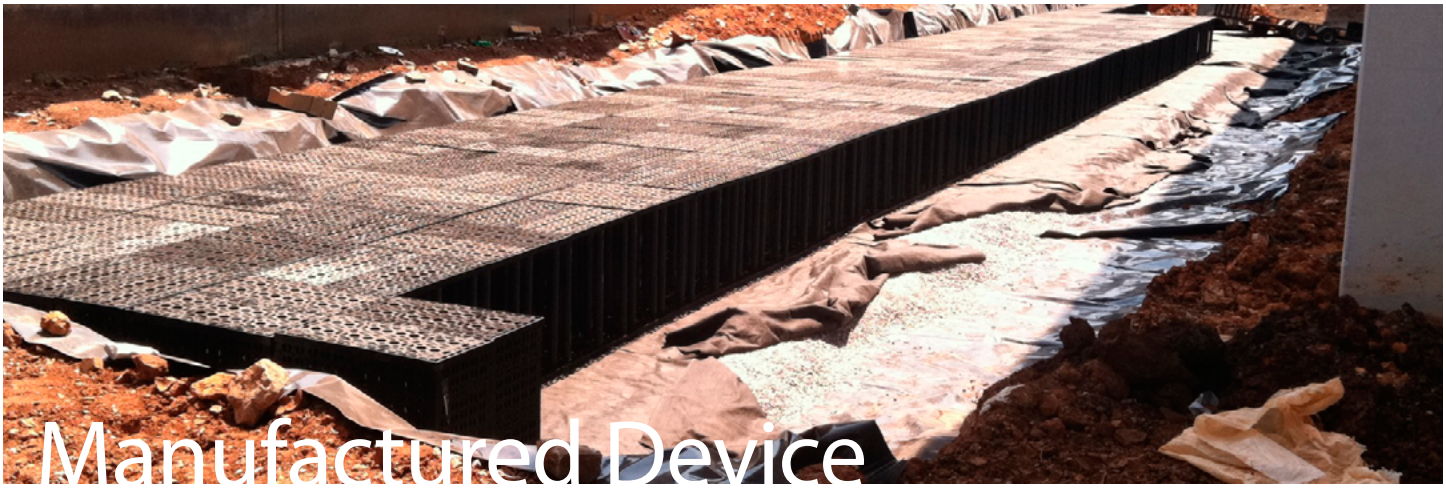
- Areas with restricted space
- Areas with limited infiltration capacity
- May be engineered to target specific pollutants

DISADVANTAGES

- Limited social, economic and environmental benefits other than water quality. Performance is highly dependent on matching hydraulic flow capacity
- Devices are not typically visible and may be "forgotten"
- More frequent maintenance may be required as compared to traditional technologies

VARIATIONS

- Catch Basin Filtration Devices
- Oil and Water Separators
- Media Filtration with Sediment Storage
- Hydrodynamic Separation



Manufactured Device

SITING

Soils: Any
Slope: Any
Floodplain: Acceptable
Water Table/Bedrock Separation: Any
Hot Areas: Acceptable

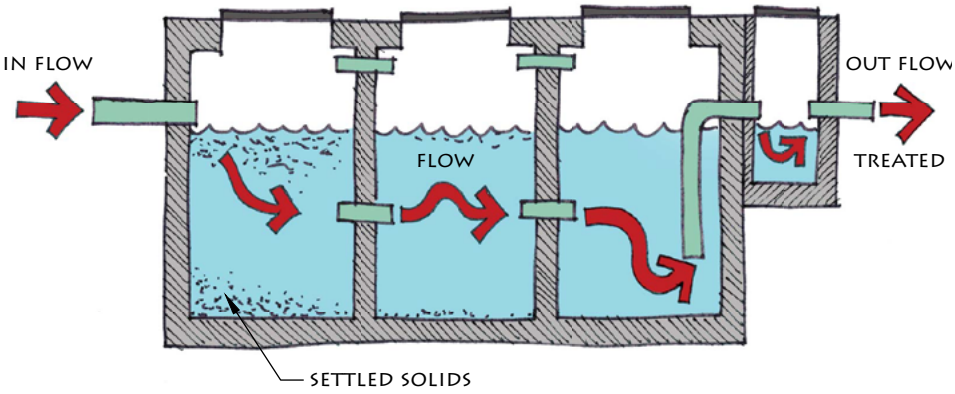
MAINTENANCE

- Comply with vendor recommendations

COST

- Varies greatly depending on technology

Pretreatment Device Cross-Section



LINKS

Resource Rain – Rainwater Management Guide:
http://www.chattanooga.gov/images/citymedia/publicworks/WQ/ResourceRain/Manual/5.3.12_Manufactured_Devices.pdf

Low Impact Development Center:
http://www.lowimpactdevelopment.org/ffxcty/2-3_filtrationdevice_draft.pdf

Performance

BMP	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation
Manufactured Device	○ / ◉	○ / ◉	○ / ◉	○ / ◉	○ / ◉	○ / ◉	○ / ◉

Table Key ○=Low ◉=Medium ●=High

Naturalized Basin

DESCRIPTION

A naturalized basin is a shallow vegetated basin that collects and filters runoff. The basins allow pollutants to settle out as water infiltrates or is retained in planting soils. An outlet structure within the basin is designed to provide peak flow rate control with positive overflow capacity. A naturalized basin may reduce the runoff volume, provide temperature mitigation, create habitat and reduce maintenance needs.

Retrofitting an existing traditional detention basin into a naturalized basin can be very cost-effective in developed areas where existing basins only provide large storm peak rate mitigation.

KEY DESIGN FEATURES

- Level or nearly level bed bottom
- Meandering flow path within basin
- Sediment forebay or other measures to trap coarse sediment at entrance locations into the basin
- Modified soils that absorb and potentially infiltrate runoff
- Modified outlet structure that retains predetermined portion of runoff
- Capacity to mitigate peak flow rates
- Limited side slopes with 3:1 maximum recommended in new naturalized basins and 4:1 preferred
- Vegetation selection
- Naturally defined boundary between lawn and naturalized area

APPLICATIONS

- Schools
- Parks
- Vacant Land
- Public Facilities

ADVANTAGES

- Provides volume reduction through retention of small storms
- Provides peak rate reduction
- Improves water quality through filtering and nutrient uptake by vegetation
- Habitat for wildlife
- Low maintenance burden after vegetation is established
- Cost-effective, especially as a retrofit optio

DISADVANTAGES

- Larger footprint to maintain a limited high water depth and still provide peak rate control
- Cannot be "forgotten" as maintenance is required for basin performance
- Vegetation must be harvested to prevent release of captured nutrients
- Signage and educations necessary

VARIATIONS

- Detention Basin Retrofits
- Wet/Dry Extended Detention
- Infiltration Basin
- Bioretention Basin
- Stormwater Wetlands

Naturalized Basin

SITING

Soils: Any

Slopes: Any

Floodplain: Acceptable

Water Table/Bedrock Separation: Any

Hot Areas: Pretreatment system/impervious liner

MAINTENANCE

- Grasses and vegetation should not be mowed to less than 4 inches in height
- Invasive species removal as needed
- Relatively low maintenance after establishment of vegetation
- No chemical maintenance (fertilizers, pesticides or herbicides)

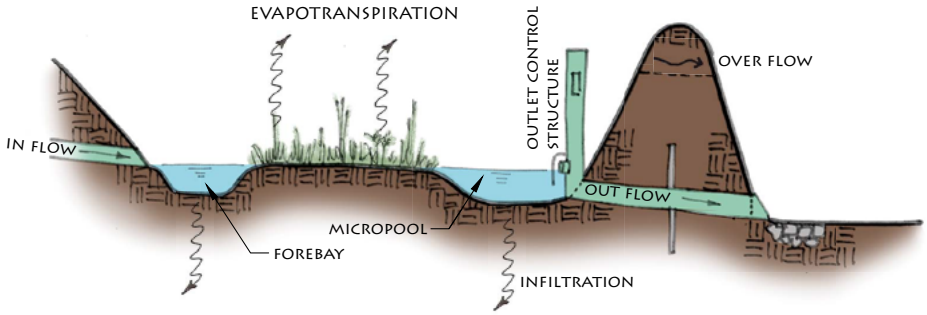
CAPITAL COST

- $5-$15 per square ft (includes soil amendment and vegetation)

VEGETATION

- Comply with Planting Guidelines in Protocol 5 of the Rainwater Management Guide

Naturalized Basin Cross-Section



LINKS

Resource Rain – Rainwater Management Guide:
http://www.chattanooga.gov/images/citymedia/publicworks/WQ/ResourceRain/Manual/5.3.13_Naturalized_Basins.pdf

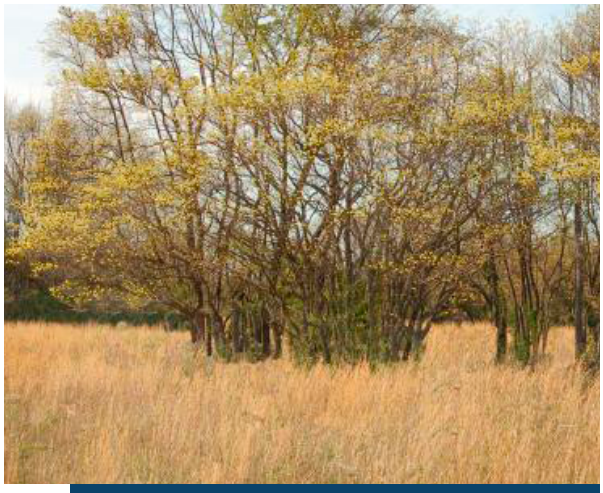
U.S. EPA:
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=67&minmeasure=5

The Stormwater Manager's Resource Center:
http://www.stormwatercenter.net/

Performance

BMP	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation
Naturalized Basin	●	●	●	●	●	●	●

Table Key ○=Low ◉=Medium ●=High



Restorative Practice

DESCRIPTIONS

RECREATE NATURAL FLOW PATTERNS

In many urban and suburban areas, flow paths have been constricted, rerouted, buried, paved, or built over until the original drainage patterns were obscured and the stormwater management benefits have been lost. Natural flow patterns create a dispersed, multi-scale drainage network including conveyance and detention as well as other components.

IMPROVE NATIVE LANDSCAPE COVER TYPES

The "natural" landscape is an important tool to reduce stormwater runoff volume and velocity and to improve water quality. Remnants of native plant communities found on development sites are frequently degraded, damaged, transformed, or partially destroyed. Restoring the landscape allows natural processes to bring about gradual recovery to an ecosystem.

Reforestation is an example of improving native landscape cover and is essential to the restoration of many natural habitats. Forested buffers that lie between land and water are an essential part of the ecosystem. Buffer establishment and reforestation, aides in park improvement, neighborhood and highway beautification, and the planting of shade trees in parking and pedestrian areas.

AMEND AND RESTORE DISTURBED SOILS

Healthy soil is a living natural system consisting of a mixture of weathered minerals, decomposing organic matter, and biological organisms, that contains adequate air and water for the support of plants. These soils permit water infiltration for groundwater recharge and provides water-holding capacity to support vegetation, both contributing to reduction in stormwater runoff.

KEY DESIGN FEATURES

RECREATE NATURAL FLOW PATTERNS

- Identify drainage patterns in site context
- Identify and map historic natural drainage features
- Erosion protection or energy dissipation measures
- Native vegetative buffers

IMPROVE NATIVE LANDSCAPE COVER

- Identify key remnant landscape cover types to be protected or enhanced (meadows, woodlands, and forests)

AMEND AND RESTORE DISTURBED SOILS

- Soil amendment composition
- Ideal soil profile
- Physical loosening of the soils can mitigate compaction.

ADVANTAGES

- Dispersed, small-scale storage
- Runoff reductions through natural processes
- Water quality enhancements
- Aeration/oxygenation of water depending on channel morphology
- Site amenity, aesthetics
- Native cover types require less maintenanc than manicured, ornamental landscapes

DISADVANTAGES

- May require other smaller BMPs over a larger portion of the site
- Enhancement efforts have a level uncertainty
- Native landscapes have an aesthetic that not all may find attractive
- Initial upfront development costs
- Specialists required for evaluation and remediation

APPLICATIONS

- Schools (streams, wetlands)
- Parks
- Vacant Land
- Private Partnerships (conservation)

VARIATIONS

- Stream Restoration
- Floodplain Restoration
- Daylighting Streams
- Urban Forests
- Soil Amendment
- Soil Remediation

Restorative Practice

SITING

Soils: Practice Dependent
Slope: Practice Dependent
Floodplain: Practice Dependent
Water Table/Bedrock Separation: N/A
Hot Areas: N/A

MAINTENANCE

- Low maintenance for natural systems
- Remove trash and debris as needed
- No chemical maintenance (fertilizers, pesticides, or herbicides)

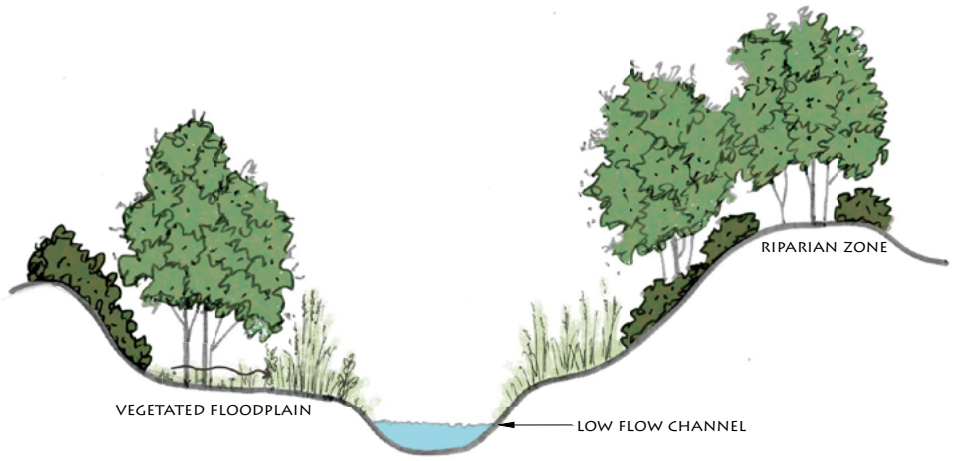
COST

- Stream Restoration - $200-600 per linear ft
- Urban Forest - $25 each for seedlings
- Soil Amendment - $1-$3 per square ft

VEGETATION

- Comply with Planting Guidelines in Protocol 5 of the Rainwater Management Guide
- Avoid cultivars and ornamentals for restoration projects

Natural Flow Path



LINKS

Resource Rain – Rainwater Management:
http://www.chattanooga.gov/images/citymedia/publicworks/WQ/ResourceRain/Manual/5.4.1_Recreate_Natural_Flow.pdf

http://www.chattanooga.gov/images/citymedia/publicworks/WQ/ResourceRain/Manual/5.4.2_Improve_Native_Landscape_Cover.pdf

http://www.chattanooga.gov/images/citymedia/publicworks/WQ/ResourceRain/Manual/5.4.3_Amend_Restore_Disturbed_Soils.pdf

Center for Wetlands & Stream Restoration:
http://www.wetlandsandstreamrestoration.org/

Iowa Department of Natural Resources:
http://www.iowadnr.gov/Portals/idnr/uploads/water/stormwater/manual/part2e.pdf

Performance

BMP	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation
Recreate Natural Flow Patterns	⊙	⊙ / ●	⊙	⊙	⊙	○	●
Improve Landscape Cover Types	●	●	⊙	⊙	●	●	●
Soil Amendment	●	●	⊙	●	⊙	⊙	●

Appendix C

Article XIV Complete Streets

Sec. 32-319. Violation declared misdemeanor; penalty.

Any person who shall violate any provision of this chapter, or any person who shall fail or refuse to comply with any notice to abate or other notice issued by the City Forester and/or City Landscape Inspector within the time allowed by such notice, shall be guilty of a misdemeanor; each day of such violation or failure or refusal to comply shall be deemed a separate offense and punishable accordingly. Each violation of this article shall be punishable by a municipal fine of not less than fifty (50) dollars and costs for each day of violation for this municipal offense. In addition to any municipal fine, any violator shall be responsible for the actual cost incurred by the City for replacing any illegally removed tree. The replacement tree and location for planting shall be determined by the City Forester.
(Ord. No. 12619, § 2, 6-26-12)

ARTICLE XIV. COMPLETE STREETS

Sec. 32-340. Definition of Complete Streets.

"Complete Streets" are streets that are designed, built and operated to enable safe access for all users, in that pedestrians, bicyclists, motorists and public transportation users of all ages and abilities are able to safely move along and across the street right-of-way.
(Ord. No. 12822, § 1, 04-01-14)

Sec. 32-341. Complete Streets Policy.

The City shall develop a safe, reliable, efficient, integrated and connected multimodal transportation system that will promote access, mobility and health for all users, and will ensure that the safety and convenience of all users of the transportation system are accommodated, including pedestrians, bicyclists, users of mass transit, motorists, emergency responders, freight providers, adjacent land owners, and people of all ages and abilities, including children, youth, families, older adults, and individuals with disabilities.
(Ord. No. 12822, § 1, 04-01-14)

Sec. 32-342. Scope of Complete Streets Applicability.

(a) All city-owned transportation facilities in the public right-of-way including, but not limited to, streets, bridges and all other connecting pathways shall be designed, constructed, operated, and maintained so that users of all ages and abilities can travel safely and independently.

(b) The City shall approach every transportation improvement project phase with the purpose to create safer, more accessible streets for all users. These phases include, but are not

limited to: planning, programming, design, right-of-way acquisition, construction, reconstruction, operation and maintenance. Other changes to transportation facilities on streets and rights-of-way, including capital improvements, re-channelization projects and major maintenance, must also be included.

(c) Privately constructed streets and drives shall adhere to this policy.

(d) The City shall foster partnerships with the State of Tennessee, neighboring communities and counties, and business and school districts to develop facilities and accommodations that further the City's Complete Streets policy.

(e) Transportation projects shall incorporate sustainable water quality management principles where applicable to reduce pollutant, temperature and runoff impacts to local waterbodies.
(Ord. No. 12822, § 1, 04-01-14)

Sec. 32-343. Exceptions.

Any exception to this policy, including for private projects, must be approved by the Administrator of the Transportation Department. Exceptions may be considered for approval when:

(a) An affected roadway prohibits use by specified users (such as a limited-access highway or a pedestrian mall), in which case a greater effort shall be made to accommodate those specified users elsewhere;

(b) The activities are ordinary maintenance activities designed to keep assets in serviceable condition (e.g. mowing, cleaning, sweeping, spot repair, or other interim measures);

(c) Severe existing topographic, natural resource, or right-of-way constraints exist that preclude construction of bicycle or pedestrian facilities without incurring excessive cost.
Exceptions granted under (a) and (c) must be documented with supporting data that indicates the basis for the decision and posted in quarterly reports on the Transportation Department webpage.
(Ord. No. 12822, § 1, 04-01-14)

Sec. 32-344. Design Standards.

The most current editions of the following engineering manuals are hereby adopted as design guidelines:

(a) The Street and Bikeway Design Guides published by the National Association of City Transportation Officials (NACTO).

(b) Designing Walkable Urban Thoroughfares, Institute of Transportation Engineers (ITE).

(c) Using these manuals as guidance, the Transportation Department will create and publish Complete Streets Design Standards to govern the design and construction of all transportation elements within the city.
(Ord. No. 12822, § 1, 04-01-14)

Sec. 32-345. Performance Measures.

The City shall measure the success of this Complete Streets policy using, but not limited to, the following performance measures:

- Total miles of bike lanes (standard, buffered and protected), bike routes, and shared-use pathways
- Total miles of pedestrian accommodation
- Percentage of intersections with ADA accessible curb ramps
- Percentage of transit stops accessible via sidewalks and bicycle facilities
- Rate of crashes, injuries, and fatalities by mode
- Rate of children walking or bicycling to school
- Commute mode share
- Mass transit ridership rates

Unless otherwise noted above, within six months of policy adoption, the City shall create individual numeric benchmarks for each of the performance measures included, as a means of tracking and measuring the annual performance of the policy. Annual reports shall be posted online for each of the above measures.
(Ord. No. 12822, § 1, 04-01-14)

Sec. 32-346. Implementation and Reporting.

The City of Chattanooga shall view Complete Streets as integral to everyday transportation decision making practices and processes. To this end:

(a) The Transportation Department, the Department of Public Works, the Department of Economic & Community Development, the Chattanooga - Hamilton County Regional Planning Agency, and other relevant departments, agencies, or committees will review and modify current

city standards, including but not limited to subdivision regulations, zoning codes and ordinances, to ensure that they effectively implement Complete Streets principles; and such groups shall incorporate Complete Streets principles into all future planning documents, manuals, design standards, checklists, decision-trees, rules, regulations, programs, neighborhood redevelopment projects, and other appropriate endeavors.

(b) When available, the City shall encourage staff professional development and training on multimodal transportation issues through attending conferences, classes, seminars, and workshops.

(c) City staff shall identify all current and potential future sources of funding for street improvements and recommend improvements to the project selection criteria to support Complete Streets projects.

(d) A periodic report (annual or otherwise, as appropriate) will be made to the City Council showing progress made in implementing this policy. The Transportation Department with assistance from the Department of Public Works, the Department of Economic & Community Development, the Chattanooga - Hamilton County Regional Planning Agency, and other relevant departments, agencies, or committees shall report on the annual increase or decrease for each performance measure contained in this policy compared to the previous year(s).

(e) Complete Streets endeavors shall be accompanied by educational elements to ensure that all users of the transportation system understand and can safely utilize project components. (Ord. 12822, §1, 04-01-14)

Appendix D

Land Use Codes

Hamilton County Government
Data Processing
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Chattanooga, TN 37402
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Email davidm@hamiltontn.gov

June 1, 1999 (last revision date)

Dear Customer;

The enclosed is a complete description of the files which the Assessor of Property has made available to you. The information following the file layouts, are tables that describe fields that contain codes. The files are stored in a self-extracting archive file called OPTXDNLD.EXE. To extract these files, run the program by double clicking it in windows explorer or by typing the name and pressing enter at the DOS prompt. Once extracted, these files will require about 150mb of hard drive space. Below is a name and brief description of each file.

OPTXNWP.DAT = General Parcel Information – This file contains basic property information, owner information, descriptions, sales information, total land value, building value, appraisal, and assessment.

OPTXNWB.DAT = Building Data – This file contains information directly related to specific buildings for specific parcels. There may be multiple buildings per parcel.

OPTXNWL.DAT = Land Data - This file contains information directly related to the land associated with the parcel. There may be multiple land records per parcel.

OPTXNWC.DAT = Commercial Building Data - This file contains information directly related to specific commercial buildings for specific parcels. There may be multiple commercial buildings per parcel.

OPTXNWM.DAT = Misc. Improvements - This file contains information directly related to misc. improvements for parcels. A misc. improvement may be a parking lot or a fence or other non-building improvement. There may be multiple misc. improvements per parcel.

If I can be of any further assistance, please don't hesitate to contact me.

Sincerely,
David Murphy
Systems Analyst

PROPERTY TYPE
TABLE

CODE	DESCRIPTION
01	County Owned
02	City Owned
03	State Owned
04	Federally Owned
05	Religious Usage
06	Fraternal Usage
07	Utility and Public Service
08	Commercial
09	Deletes or Combines
10	Industrial
11	Chattanooga Housing Authority
12	Back Tax
13	Hospital Authority
14	County Schools
15	City Schools
16	Cemeteries
17	Farms
18	Forest
19	Homestead
20	Mineral
21	Community Lot
22	Residential
23	Town of Lookout Mtn
24	Signal Mtn
25	East Ridge
26	Red Bank
27	Soddy Daisy
28	Collegedale
29	Ridgeside
30	Lakesite
31	Walden
32	Rental Property 40%, e.g. Apartment
33	Former Greenbelt
34	Open Space
40	Apartment (117)
45	Golf Courses
98	In Lieu of & Deferred Taxes
99	Unworked Parcel

STANDARD LAND USE CODES
TABLE 1.0

The system may best be described as hierarchical to the extent that property may always be described in some fashion (e.g. subdivision, division, and category.

100 RESIDENTIAL

110 Household Units

111 One Family Household Unit
112 Two Family Household Unit (Duplex)
113 Multi-Family (4-9 unit Apartment)
114 Two Family Units (Duplex Owner Occupied)
115 Triplex
116 Condominium,
117 Apartment: 10 units or more

120 Group Quarters
Rooming and boarding houses, fraternity and sorority house and other membership lodgings. Nursing homes, college dormitories, other halls or dormitories, retirement homes, religious quarters, orphanages, convents.

130 (Reserved for future use)

140 Mobile Homes

141 Mobile Homes (Single Trailer)
142 Mobile Home Park
143 Mobile Home Park (Privately Owned)

150 Transient Lodging
Motels, tourist courts, lodges, hotels and other transient lodgings.

200 MANUFACTURING

210 Food Manufacturing
Meat, poultry and small game dressing and packing. Creamery butter, cheese natural and processed, Milk, ice cream and frozen desserts. Seafoods, fruits, vegetables, jams, and jellies canning. Flour and other grain mill products. Bakery products.

220 Textile Mill Products Manufacturing
Woven fabrics, knit goods, dying and finishing of textile, floor coverings, yarn and threads and other textile mill products.

230 Apparel Manufacturing
Men and boys clothing, women and girl clothing
Leather and leather products, fun goods and miscel-
laneous apparel and accessories.

STANDARD LAND USE CODES
TABLE 1.0

240 Lumber and Wood Products Manufacturing
Logging camp and logging contractors, sawmills, mill work, wooden container products.

250 Furniture and Fixtures Manufacturing
Household furniture, office furniture partitions shelving, lockers and store fixtures.

260 Paper products Manufacturing
Paper, paperboard, converted paper products, containers and boxes and building board paper.

270 Printing, Publishing and Allied Industries
Manufacturing, newspapers, periodicals, books and commercial publishing and printing.

280 Chemicals and Allied Products Manufacturing
Industrial chemicals, plastic, synthetic and rubber man-made fibers, drugs, soaps,, cosmetics, paint, varnishes, and allied products, agriculture chemicals and all other allied products.

290 Petroleum Refining Manufacturing
Refining petroleum products and allied products.

291 Petroleum Tank Farms

292 Paving and Roofing Materials

293 Paving Equipment

300 MANUFACTURING

310 Ancillary to Manufacturing

311 office Building Ancillary to Manufacturing

312 Warehouse Building Ancillary to Manufacturing

313 Service or Parking Building Ancillary to Manufacturing

314 Retail or wholesale ancillary to manufacturing

320 Stone, Concrete and Glass Products Manufacturing
Flatglass, glass containers, cement, brick, ceramic tile, and clav products, china plumbing fixtures, porcelain, electrical supplies, concrete, brick and block and concrete mix, cut stone and stone products.

330 Iron, Steel and Metal Manufacturing, Blast Furnaces, steel works rolling and finishing, iron and steel foundries smelting and refining metals, steel pipe and tubes.

340 Fabricated Metal Products Manufacturing
Guns and accessories, general industrial machinery and equipment, office, computing and accounting machines, household appliances, communications equipment, motor vehicles and motor vehicle equipment, aircraft parts, railroad e@uipment, metal cans, cutlery, hand tools and general har ware.

350 Professional, Scientific, and Controlling Instruments, Photographic and Optical Goods, Watch and Clocks Manufacturing
Engineering, laboratory and scientific equipment, instruments for measuring, optical instruments and lensest ophthalmic goods, photographic equipment, watches, clock operated devices, dental equipment.

390 Miscellaneous Manufacturing_.

391 Jewelry, silverware and plated ware
392 musical instruments and parts
393 Toys, amusement, sorting and athletic goods
394 Pens, pencils and other office and artist materials
395 Costume jewelry, costume novelties, buttons and miscellaneous notions
396 (Reserved for future use)
397 Recording studios and movie studios

400 TRANSPORTATION, COMMUNI CATIONS AND UTILITIES

410 Rail Transportation
Railroad right-of-way, railroad repair yards, railroad terminals.

420 Motor Vehicle Transportation
Bus terminals, bus repairs, motor freight terminals, motor freight repair, garages, taxicabs.

430 Aircraft Transportation

431 Airports
432 Airports repair hangers

440 Marine Craft Transportation
Marine terminals, marine repair docks, other marine craft or terminals.

450 Highway and Street Right of Way

STANDARD LAND USE CODES
TABLE 1.0

460 Automobile Parking

461 Private parking (service or garage)
462 Parking ancillary to manufacturing
468 Commercial service parking lots
469 Commercial parking garage

470 Communications (Telephone, Radio, T.V., etc.)
Telephone exchange stations, relay towers, telegraph message centers transmitting and receiving stations, radio and T.V. broadcasting studios, transmitting stations and relay towers.

480 utilities

481 Electric utilities
482 Gas utilities
483 Water utilities
484 Sewage utilities
485 Solid waste disposal utilities
486 Other transportation comm and utilities

490 Warehouse

491 (Reserved for future use)
492 Warehouse Storage
493 Distribution-Warehouse
494 Mini Warehouse

500 WHOLESALE AND RETAIL TRADE

510 Wholesale Trade
Automotive equipment, drugs, chemicals, dry goods and apparel, groceries, farm products, electrical goods, hardware, plumbing, heating equipment and supplies, machinery, equipment and supplies.

520 Retail Trade Equipment

521 Lumber and other building materials
522 Heating and plumbing equipment
523 Paint, glass and wall paper
524 Electrical supplies
525 Hardware and farm equipment
526 Sporting goods

530 Retail Trade - General

531 Department stores
536 Discount department stores
537 Antiques and second hand
538 Drugstores

STANDARD LAND USE CODES
TABLE 1.0

540 Retail Trade - Food
- 541 Groceries (supermarkets)
- 542 Meats and fish markets
- 543 Fruits and vegetables
- 544 Candy, nuts and confectionery
- 545 Dairy products
- 546 Bakeries
- 547 Liquor
- 548 Groceries, convenience shops (drive-in type)

550 Retail Trade - Automotive, marine, Aircraft
- 551 Motor vehicle new
- 552 Tires, batteries and auto accessories
- 553 Service stations
- 554 motor vehicles used
- 555 Automotive junkyards
- 556 Marine craft and accessories
- 557 Farm equipment
- 558 Motorcycles (new and used)

560 Retail - Apparel and Accessories
Men's and boys' furnishings
Women's and girls' furnishings
children's and infants'-furnishings
Accessories and specialties
Shoes, custom tailoring, fun apparel.

570 Retail Furniture, Home Furnishings and Equipment
Furniture and home furnishings, household appliances, radios, televisions and home electronic supplies and music supplies, florists and garden supplies, floor coverings, draperies, china, glass and metal ware.

580 Retail Trade Eating and Drinking
- 583 Restaurants typically those which provide full-course meals
- 584 Diners and luncheonettes characterized by counter service, limited.
- 585 Snack bars, drive-ins with window and/or car service, possibly limited counter service.
- 586 (Reserved for future use)
- 587 Bars and taverns
- 590 Other Retail Trades

STANDARD LAND USE CODES
TABLE 1.0

600 SERVICES

- 610 Finance, Insurance and Real Estate Services
- 611 Banking and bank related services
- 612 Credit and loan (other than bank)
- 613 Bank complex with office building
- 614 Insurance carriers, agents and brokers
- 615 Real estate brokers
- 616 (Reserved for future use)
- 617 Insurance corporate.office
- 620 Personal Service
  Laundering, dry cleaning, laundromat,, photographic service, beauty and barber services, apparel repair, shoe repair, funeral and cemetery services.
- 630 Business Services
  Advertising, consumer and mercantile, credit reporting, duplicating, mailing, janitorial, exterminating employment equipment rental, photo finishing anA all other business services.
- 640 Repair Services
  Automobile repair, wash service, electrical, radio, T.V. repair service, watch, clock, and jewelry repair services, re-upholstery and furniture repair service.
- 650 Professional Services
  - 651 (Reserved for future use)
  - 652 Legal services
  - 653 Medical clinics and doctors out-patient service
  - 654 Hospitals, convalescent and sanitariums
  - 655 Engineering and architectural
  - 656 Accounting, auditing, and bookkeeping
  - 657 Medical and dental labs
  - 658 Dentists
  - 659 Veterinarian Clinics & Hospitals

STANDARD LAND USE CODES
TABLE 1.0

660 Contract Construction Services
Building contractors, plumbing, heating and air-conditioning, painting, paper hanging and decorating, electrical, masonry, carpentering, roofing, and other special contract construction services.

670 Governmental Functions and Services

671 Executive, legislative, and judicial functions
672 Protective functions (police, fire, civil defense)
673 Postal functions
674 Correctional functions
675 Reserved for future use
676 Government construction and maintenance yards

680 Educational Services

682 University, colleges and junior colleges
683 Vocational and special training
684 Nursery schools and day care centers
685 Elementary schools
686 Junior high schools
687 Senior high schools

690 Other Services

691 Churches-, synagogues, and temples
692 Welfare and charitable services
693 (Reserved for future use)
694 (Reserved for future use)
695 Labor unions and fraternal associations

700 CULTURAL, ENTERTAINMENT, AND RECREATIONAL

710 Cultural activities and nature exhibitions
Libraries, museums and art galleries, planetaria, aquariums and zoos, botanical gardens, arboretums and bird sanctuaries and other nature exhibitions, historic and other nature exhibitions.

720 Public Assembly - Auditoriums and exhibiton halls, theaters, and amphitheaters, motion picture theaters drive in, arenas and stadiums race tracks and other public assembly.

730 Amusement
Fairgrounds, miniature golf, golf driving ranges, go-cart tracts and other amusements.

STANDARD LAND USE CODES
TABLE 1.0

740 Community lots, Playgrounds and athletic areas, swimming areas, boat docks., skating areas, riding stables, etc.-

741 Marinas and Camping Areas

742 Bowling Alleys

743 Golf Courses - Public and Private

750 Resort and Group Camps
General resorts, group or organized camps, health resorts, hunting and fishing clubs.-

760 Parks
Parks leisure or ornamental, neighborhood, and regional parks.

800 RESOURCE PRODUCTION AND EXTRACTIONS

810 Agricultural
Predominant crop of fruits, nuts, vegetables or dairy, poultry, livestock or general farm.

820 Agricultural Related Activities
Poultry hatchery services, horticultural services.

830 Forestry Activities and Related Services
Forestry nurseries, commercial forestry production

850 Mining Activities and Related Services
Metal ore, coal, and crude petroleum mining and natural .gas mining and quarrying of nonmetallic minerals.

900 UNDEVELOPED LAND AND WATER AREAS

910 Undeveloped and Unused Land

911 Vacant land suitable for development
912 Vacant land not suitable for development
914 Vacant land commercial
915 Vacant land industrial
916 V'a4@ant land commercial (fenced)
917 Vacant land industrial (fenced)
918 Vacant land condominiums
920 Forests
930 Water Areas
960 Cemeteries
970 Combined or Deletes - Properties combined or deleted from property file.

Appendix E

Land Use Aligned with GI Strategy

Table D-1
Land Use Aligned with GI Strategy

GI Strategy	Land Use Category	Land Use Subcategory	Land Use Code Range
Green Housing	Residential	Residential	100-150
Green Parking	Transportation, Communication, and Utilities	Transportation and Parking	410-469
Green Public Facilities and Services	Transportation, Communication, and Utilities	Communications, Utilities, and Warehouse	470-495
	Services	General Services	600-676, 693-694
	Services	Hospitals	650, 653-654
	Cultural, Entertainment, and Recreational	Recreation	700-750
Green Schools	Services	Schools	680-687
Green Open Spaces	Cultural, Entertainment, and Recreational	Parks	760
	Undeveloped and Unused Land	Undeveloped and Unused Land	0, 900-970
Green Streets	City and Public ROW	City and Public ROW	None[a]
Green Partnerships	Manufacturing	Manufacturing (Industrial)	200-397
	Wholesale and Retail Trade	Wholesale and Retail Trade (Commercial)	500-590
	Services	Churches and Charities	690-695
	Railroad ROW	Railroad ROW	None[a]

[a] Land use code ranges apply to parcels which does not include City, public, or railroad ROW.

Appendix F

Assessment of GI Potential Data

Methodology

Within each scenario, an assumed percentage of imperviousness is be managed by GI. Using the calculation outlined in the RMG Section 7.3, the stay-on-volume (SOV) was computed to manage the area derived from the assumed percentage of impervious area managed. RMG Section 7.6 was then used to adjust the CN to reflect the SOV. The new curve number results from the difference in the original depth of runoff (Q) and the retention storage (R) provided by the SOV. The retention storage value is, effectively, the volume of runoff reduced from the baseline scenario.

Inputs

The following data was developed and input into the assessment calculations:

- Area (acres) – Compiled from the comprehensive land use analysis.
- Impervious Area (acres) – Analyzed and developed in comprehensive land use analysis.
- Depth of Rainfall, P (in) – The two (2)-year, 24-hour rainfall depth which was determined the level of service to be met in the LTCP.
- Assumed Percent, %, of Impervious Area Managed (%) – This input varies with the applicable scenario. The target demonstration scenario implements a range of percentage values for each GI strategy. For the four (4) generic scenarios, 5%, 10%, 15%, and 20% of impervious area were targeted for management with GI controls.
- Depth of Rainfall Management Goal, P_{GOAL} (in) – The depth of rainfall management was used to compute the SOV. A range of Rv values are provided in the RMG for depth of rainfalls at 0.5”, 1.0”, 1.6”, and 2.1” depths. The target demonstration scenario explores the impacts of implementing 1” and 2.1” depth targets for select strategies and the generic scenarios employ each (0.5”, 1.0”, 1.6”, and 2.1”) SOV depth.

Assumptions

The following assumptions were applied in order to determine the potential impact of GI.

- Underlying assumptions associated with calculation methodology (TR-55 and RMG Chapter 7).
- Composite CNs were developed based upon the delineation of pervious and impervious land cover areas according to Table E-1.

Table E-1
Composite Curve Number Development Assumptions

Land Cover	CN	Assumption
Impervious Areas	98	Paved lots, roof, driveways, etc.
Pervious Areas	80	Open Spaces (parks, golf courses, cemeteries, etc.); Good; D

- All impervious areas were represented as "Large Impervious Areas" and assigned an Rv of 0.98 for 1.0" rainfall depth managed. Refer to the RMG Table 7-1 for small storm hydrology coefficients (Rv) for urban land uses.
- The retention storage volume (R) is a representation of stormwater runoff removed from the CSS.

Calculations

$$CN = \%\ Impervious\ \times\ 98 + \%\ Pervious\ \times\ 80$$

$$S = \frac{1000}{CN} - 10$$

$$I_a = 0.2 \times S$$

$$Q = \frac{(P_{2-yr,24-hr} - I_a)^2}{P_{2-yr,24-hr} - I_a + S}$$

$$Area\ Managed = Impervious\ Area\ \times Assumed\ \%\ Managed$$

$$SOV = Area\ Managed \times P_{GOAL} \times R_v \times \frac{43{,}560\ {}^{sq\ ft}/_{ac}}{12\ {}^{in}/_{ft}}$$

$$R = \frac{SOV}{Area} \times \frac{12\ {}^{in}/_{ft}}{43{,}560\ {}^{sq\ ft}/_{ac}}$$

$$Q - R = \frac{(P_{2-yr,24-hr} - 0.2\ S_{mod})^2}{P_{2-yr,24-hr} + 0.8\ S_{mod}}$$

Solve for S_{mod};

$$CN_{ADJ} = \frac{1000}{S_{mod} + 10}$$

Scenarios

1. Baseline Scenario

The impervious areas determined in Section 3.1.3 were used to develop a curve number (CN) for each GI strategy and land use subcategory. Using standard Technical Release 55 (TR-55) calculations, the depth of runoff (Q) was computed for the City owned properties, using a composite CN, and for the total CSS area, using a composite CN representative of that area. The two (2)-year, 24-hour rainfall of 3.7" was used for the standard storm event. The resulting runoff depth of 2.54" and 2.50" represents the flow produced under existing conditions for the City owned properties and the total CSS area, respectively.

2. Generic Scenarios

From the baseline scenario, multiple generic scenarios were developed which consist of representations of varied levels of GI implementation to assess the potential reduction of flow on City owned property and across all properties in the CSS area using GI. The implementation levels reflected potential scenarios in which management of runoff may be achieved. The scenarios are modeled as a reduction of 5%, 10%, 15%, and 20% of the total imperviousness of the CSS area for various SOVs, meaning that the imperviousness is reduced by those percentages through an unspecified GI strategy.

The generic scenarios of 5%, 10%, 15%, and 20% implementation levels are calculated using Table E-1. These implementation levels were projected to adjust the baseline CN to adjusted CNs (CN_{ADJ}) which correspond to retained stormwater runoff volumes in the "R (gal)" column of Table E-2.

3. Target Demonstration Scenarios

Using the generic scenarios as a gauge, a target demonstration scenario was developed to allow the City to customize the amount of impervious areas managed and depth of rainfall managed by GI strategy and land use subcategory. Results from the comprehensive land use analysis support the decisions for setting targets for both the amount of impervious areas managed and depth of rainfall managed.

Targets for the amount of impervious area managed take into account the current imperviousness. Targets for the depth of rainfall managed range from 1" to 2.1" for select City properties within the CSS area.

The target demonstration scenario for City owned properties calculated in Table E-3. This target demonstration scenariou results in a CN adjustment from 89 to 88.34. This translates to a potential reduction of 1 MG of stormwater runoff from the CSS during the two (2)-year, 24-hour storm event.

Table E-2
Assessment of GI Potential on City Properties for Generic Scenarios

Scenario	GI Implementation	Area (acres)	Impervious Area (acres)	% Impervious	% Pervious	CN	2-yr, 24-hr P	Eqn. 2-3 S	Eqn. 2-2 Ia	Eqn. 2-1 Q (in)	Assumed % Managed	Area Managed	P_{GOAL}	P=1, Large Imp. Rv	SOV	R	Q-R	Smod	CNadj	R (gal)
Generic CSS Area Scenario 1	5% Implementation Level	682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	5%	17.02	0.50	0.98	30267	0.01	2.5279	1.26	88.84	226,410
		682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	5%	17.02	1.00	0.98	60533	0.02	2.5157	1.27	88.71	452,820
		682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	5%	17.02	1.60	0.98	96854	0.04	2.5011	1.29	88.54	724,512
		682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	5%	17.02	2.10	0.98	127120	0.05	2.4889	1.31	88.41	950,922
Generic CSS Area Scenario 2	10% Implementation Level	682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	10%	34.03	0.50	0.98	60533	0.02	2.5157	1.27	88.70	452,820
		682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	10%	34.03	1.00	0.98	121067	0.05	2.4913	1.31	88.44	905,640
		682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	10%	34.03	1.60	0.98	193707	0.08	2.4620	1.35	88.11	1,449,024
		682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	10%	34.03	2.10	0.98	254240	0.10	2.4376	1.38	87.84	1,901,844
Generic CSS Area Scenario 3	15% Implementation Level	682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	15%	51.05	0.50	0.98	90800	0.04	2.5035	1.29	88.57	679,230
		682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	15%	51.05	1.00	0.98	181600	0.07	2.4669	1.34	88.17	1,358,460
		682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	15%	51.05	1.60	0.98	290561	0.12	2.4229	1.41	87.68	2,173,536
		682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	15%	51.05	2.10	0.98	381361	0.15	2.3863	1.46	87.26	2,852,766
Generic CSS Area Scenario 4	20% Implementation Level	682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	20%	68.06	0.50	0.98	121067	0.05	2.4913	1.31	88.44	905,640
		682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	20%	68.06	1.00	0.98	242134	0.10	2.4425	1.38	87.90	1,811,280
		682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	20%	68.06	1.60	0.98	387414	0.16	2.3838	1.46	87.24	2,898,048
		682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	20%	68.06	2.10	0.98	508481	0.21	2.3350	1.54	86.68	3,803,689

Table E-3
Assessment of GI Potential on City Owned Parcels and City ROW for Target Demonstration Scenario

							2-yr, 24-hr	Eqn. 2-3	Eqn. 2-2	Eqn. 2-1				P=1, Large Imp.						
Strategy	**Land Use Group Summary**	**Area (acres)**	**Impervious Area (acres)**	**% Impervious**	**% Pervious**	**CN**	**P**	**S**	**Ia**	**Q (in)**	**Assumed % Managed**	**Area Managed**	**P_{GOAL}**	**Rv**	**SOV**	**R**	**Q-R**	**Smod**	**CNadj**	**R (gal)**
Green Housing	Residential	0.59	0.00	0%	100%	80	3.7	2.50	0.50	1.80	0%	0.00	1.00	0.98	0	0.00	1.7965	2.50	80.00	-
Green Parking	Transportation and Parking	2.70	2.34	87%	13%	96	3.7	0.46	0.09	3.20	33%	0.77	1.00	0.98	2751	0.28	2.9193	0.76	92.92	20,580
Green Public Facilities and Services	Communications, Utilities, and Warehouses	0.71	0.38	53%	47%	90	3.7	1.16	0.23	2.60	0%	0.00	1.00	0.98	0	0.00	2.5953	1.16	89.57	-
	General Services	58.49	22.53	39%	61%	87	3.7	1.50	0.30	2.36	6%	1.35	1.00	0.98	4809	0.02	2.3345	1.54	86.67	35,977
	Hospitals	0.00	0.00	-	-	-	3.7	-	-	-	0%	0.00	1.00	0.98	0	-	-	-	0.00	-
	Recreation	8.39	4.57	54%	46%	90	3.7	1.14	0.23	2.62	40%	1.83	1.00	0.98	6501	0.21	2.4039	1.43	87.47	48,634
Green Schools	Schools	1.30	0.93	72%	28%	93	3.7	0.76	0.15	2.92	0%	0.00	1.00	0.98	0	0.00	2.9213	0.76	92.93	-
Green Open Spaces	Parks	49.61	19.93	40%	60%	87	3.7	1.46	0.29	2.38	50%	9.96	2.10	0.98	74441	0.41	1.9699	2.16	82.27	556,857
	Undeveloped and Unused Land	53.06	10.52	20%	80%	84	3.7	1.97	0.39	2.07	10%	1.05	2.10	0.98	7855	0.04	2.0328	2.04	83.06	58,762
Green Streets	Right-Of-Way	488.70	264.43	54%	46%	90	3.7	1.14	0.23	2.61	5%	13.22	1.00	0.98	47034	0.03	2.5848	1.18	89.46	351,839
Green Partnership	Manufacturing (Industrial)	10.84	6.83	63%	37%	91	3.7	0.95	0.19	2.77	0%	0.00	1.00	0.98	0	0.00	2.7651	0.95	91.35	-
	Wholesale and Retail Trade (Commercial)	8.31	7.86	95%	5%	97	3.7	0.31	0.06	3.36	0%	0.00	1.00	0.98	0	0.00	3.3556	0.31	97.02	-
	Churches and Charities	0.00	0.00	-	-	-	3.7	-	-	-	0%	0.00	1.00	0.98	0	-	-	-	0.00	-
	Railroad	0.00	0.00	-	-	-	3.7	-	-	-	0%	0.00	1.00	0.98	0	-	-	-	0.00	-
Custom Scenario	Target Demonstration Level	682.70	340.32	50%	50%	89	3.7	1.24	0.25	2.54	8%	28.19	1.43	0.98	143393	0.06	2.4823	1.32	88.34	1,072,649

Appendix G

Field Assessments

Field Assessment

Potential GI Project	**Site #1 – Warner Park**
CSS Basin	**8**
Location	**301 N. Holtzclaw Ave**
Surrounding Area	**Urban**

Feasibility

Recommended BMP application

Improve Ground Cover Type, Pervious Pavement, Naturalize Existing Basins, Green Roof, Cisterns, Infiltration Beds, Infiltration Trenches – Large Site, Concept can be phased

Technical constraints

N/A – An initial geotechnical evaluation will be reguried, but otherwise this site is very suitable for a wide array of GI Controls. Due to the fact that this site is large, a phased approach to control costs may be optimal.

Visual social constraints/benefits

This site is comprised of an existing park so it has a lot of public access. It would be a great demonstration spot for the use of GI Controls to serve as public education and outreach. GI installation at this site can demonstrate water quality, volume control, heat reduction, improvement to air quality, energy cost reduction, and other types of GI benefits.

Summary: Site has available space for GI implementation. Its proximity to the Zoo and other park amenities provide a high social benefit, and the site has the capability to capture and treat run-off from upland areas. The initial phase would be to implement 15% tree canopy and amend existing urban soils. Additional phases may include green parking, green open space and infiltration practices for targeted impervious surfaces.

City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: Warner Park

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 100 200 400
Feet

Field Assessment

Potential GI Project	**Site #2 – Miller Park**
CSS Basin	**2**
Location	**928 Market Street**
Surrounding Area	**Downtown**

Feasibility

Recommended BMP application

Pervious Pavement, Green Roof (Per RFQ if new building added), Increase Tree Canopy, Cistern; Infiltration Bed/Trench

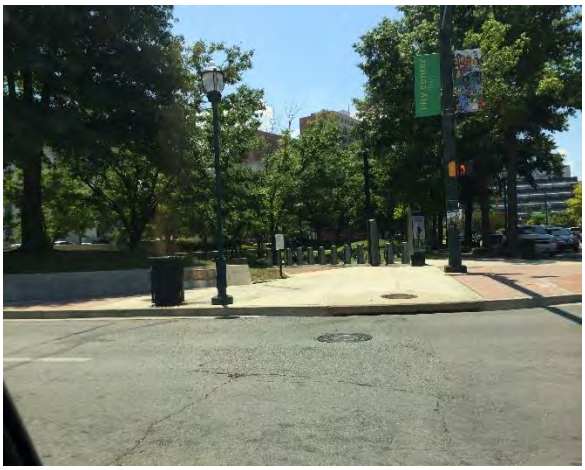
Technical constraints

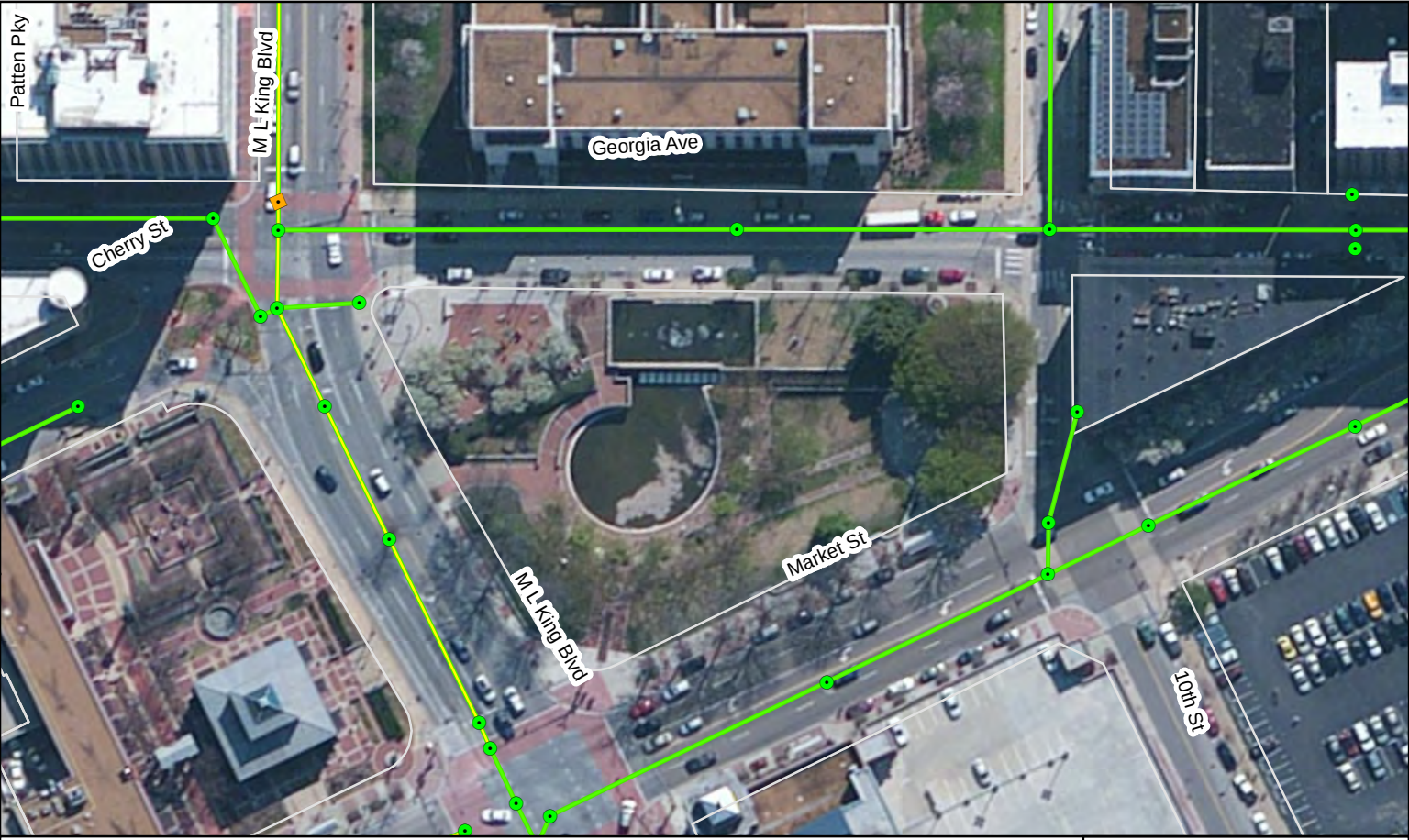
This site is located in a densely developed area. There are likely to be a lot of utilities that will require a lot of coordination. This site is small and has mature vegetation to protect.

Visual social constraints/benefits

This site is comprised of a poplar public area with a lot of visibility.

Summary Notes: The site already has established vegetation and is a public open space. However, the City is considering an RFQ at this time for concepts related to the park and to Miller Plaza. The RFG includes the potential for the addition of a building. A green roof, cistern and pervious walks would be viable implementation options for GI Controls. The site has very high social value, but the space is extremely limited. There is no opportunity to treat run-off from upland areas. Because this site being reviewed for planning, now is the time to consider implementation of GI controls.





City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: Miller Park

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 25 50 100
Feet

Field Assessment

Potential GI Project	**Site #3 – Fort Negley Park**
CSS Basin	**6**
Location	**1704 Mitchell Ave**
Surrounding Area	**Suburban**

Feasibility

Recommended BMP application

Bioretention, Infiltration Trench, Infiltration Bed

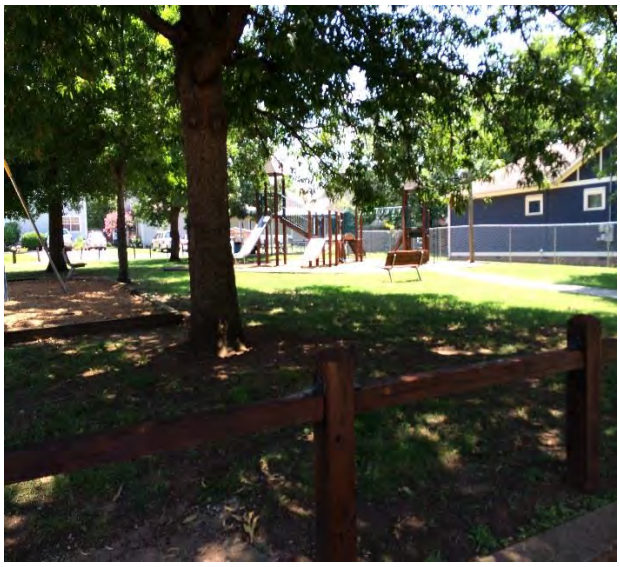
Technical constraints

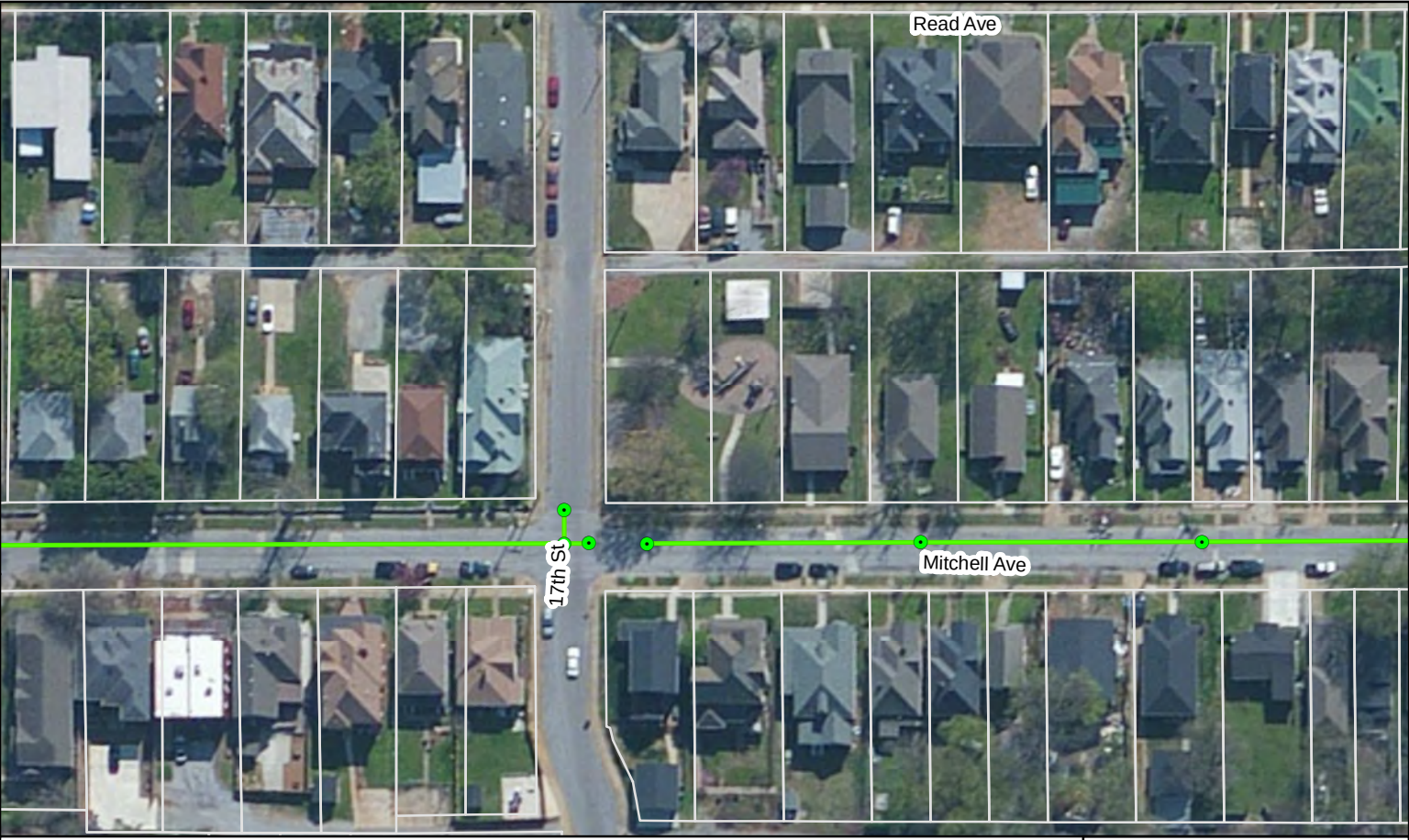
N/A - Site is located in a suburban residential area and includes a local park with existing playground. The size of the established trees will serve as a constraint.

Visual social constraints/benefits

This site would be a good place for public education and an edible garden or similar community resource to create public interest. The streetscape could be improved and pervious pavement and infiltration trenches used in the parking area for localized drainage control.

Summary Notes: This site is very small, but has a high social value. This site could be best used for workshops and a pilot rain garden or rain barrel demonstration site. There is no opportunity to manage run-off from upland areas at this location.





City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: Ft. Negley Park

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 25 50 100

Feet

Field Assessment

Potential GI Project	**Site #4 – E. 10th Street Playground**
CSS Basin	**6**
Location	**1003 E. 10th Street**
Surrounding Area	**Suburban**

Feasibility

Recommended BMP application

Bioretention, Pervious Pavement, Infiltration Bed, Infiltration Trench

Technical constraints

Site is located on high ground; therefore, a check for shallow rock would be necessary. This location is in the upper portion of its sewershed, but it would also catch flows from upstream areas, so total effect could be doubled using oversized controls. The GI controls could also be combined with a streetscape using pervious pavement and infiltration trenches.

Visual social constraints/benefits

This site is a public area, located in a suburban residential area, but the park does not appear to be heavily used. GI controls combined with an edible garden, or other community involvement use, could be used to develop community interest.

Summary Notes: The site has enough space for GI Implementation. It has a high social benefit due to existing use as playground and has potential to manage run-off from upland areas.

City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: East 10th Street Playground

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 25 50 100
Feet

Field Assessment

Potential GI Project	**Site #5 – Ross's Landing Park**
CSS Basin	**2**
Location	**101 Riverfront Parkway**
Surrounding Area	**Downtown (Riverfront)**

Feasibility

Recommended BMP application

Bioretention, Pervious Pavement, Infiltration Bed, Infiltration Trench, Increase Tree Canopy

Technical constraints

Portions of site are located close enough to the river that elevations would need to be checked to ensure that the any controls implemented remain out of the flood zone. The site is large, so the implementation of GI controls may need to be phased.

Visual social constraints/benefits

This site is extremely visible so it may be good for developing public involvement, community assistance, public education and outreach. This site receives flows from a large area upstream, so up sizing the controls for this area could create regional volume control.

Summary Notes: This site consists of Riverfront Pkwy ROW, Power Alley ROW, public and private parking areas and Ross's Landing Park. This site has a high potential for GI Implementation due to the large area available and the versatility of the location. These sites considered individually or as a cluster of sites have a large amount of space available, very high social benefit, and have the capacity to manage large amounts of run-off from upland areas.

City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: Ross's Landing Area

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 100 200 400
Feet

Field Assessment

Potential GI Project	**Site #6 – Hunter Museum of Art**
CSS Basin	**2**
Location	**2 Bluff View**
Surrounding Area	**Downtown**

Feasibility

Recommended BMP application

Bioretention, Pervious Pavement, Infiltration Bed, Infiltration Trench, Green Roof, Cisterns

Technical constraints

Site is located on high ground so it would not capture much area. The GI controls integrated into this site would probably require a lot of finesse due to the high value of the landscaping and architectural value of the area. The cost may be very high.

Visual social constraints/benefits

The site is extremely visible and may be good for developing public involvement, community assistance, and public education and outreach. This location would be a good exhibit, or pilot location for a specific controls such as a green roof and a rain garden.

Summary Notes: This site will has limited space for the implementation of GI. It has a very high social value. It is not capable of managing run-off from upland areas.

City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: Hunter Museum of Art

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 50 100 200
Feet

Field Assessment

Potential GI Project	**Site #7 – Harris Johnson Park**
CSS Basin	**4**
Location	**41 W. 28th Street**
Surrounding Area	**Urban/Suburban/Commercial**

Feasibility

Recommended BMP application

Improve Ground Cover Type, Pervious Pavement, Naturalize Existing Basins, Green Roof, Cisterns, Infiltration Beds, Infiltration Trenches – Large Site, Concept can be phased between implementation of controls.

Technical constraints

N/A – This site will require an initial geotechnical evaluation, but otherwise site is very suitable for a wide array of GI Controls. Because the site is large, GI controls should be phased to reduce that impact by the expected high costs.

Visual social constraints/benefits

The site is an existing park, so it has a lot of public access, and could be a great demonstration spot, providing a great opportunity for public education and outreach.

Summary Notes: The site has a large amount of space available for implementation of GI. Small areas of the ROW and possibly some small upland areas adjacent to the park could be managed by this area. The site has a high social benefit.

Field Assessment

Potential GI Project	**Site #8 – Long St. & W. 26th Street**
CSS Basin	**4**
Location	**41 W. 28th Street**
Surrounding Area	**Suburban**

Feasibility

Recommended BMP application

Infiltration bed, bio retention, infiltration trench

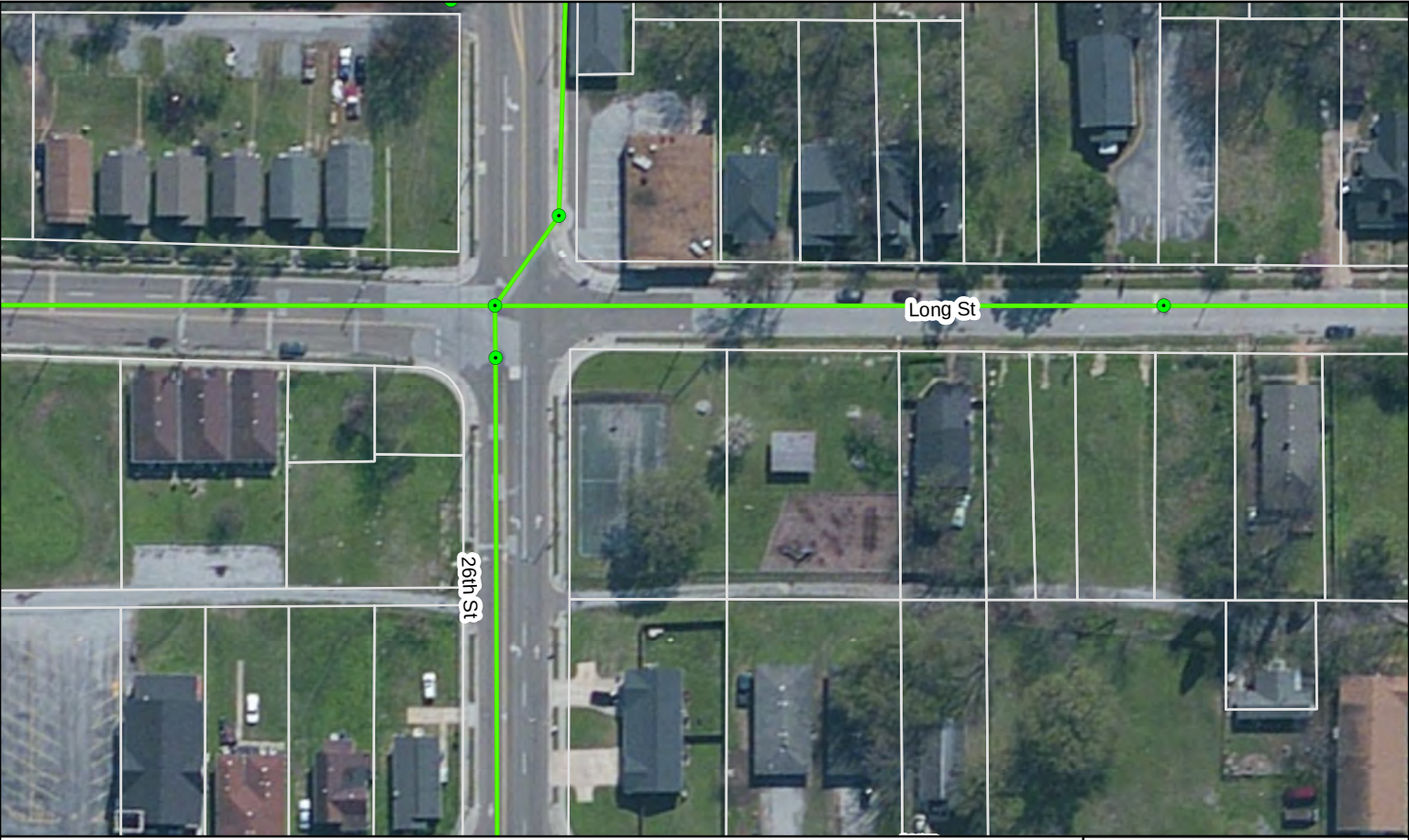
Technical constraints

N/A – The site will require an initial geotechnical evaluation, but otherwise site is very suitable for a wide array of GI controls. Site is very small. It may be better to combine the GI controls on this site with the streetscape and additional drainage improvements.

Visual social constraints/benefits

The site includes an existing park. The use of an edible garden or other community involvement activity may provide for neighborhood revitalization, and community interest.

Site Summary: The Site is very small so there is limited space for GI application, but the site has high potential for social benefit. The site has a low potential to manage run-off from upland areas.



City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: Long Street at West 26th Street

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 25 50 100
Feet

Field Assessment

Potential GI Project	**Site #9 – William St. (28th to 27th)**
CSS Basin	**4**
Location	**2709 William St**
Surrounding Area	**Suburban**

Feasibility

Recommended BMP application

Infiltration trenches, Increase Tree Canopy, Amend Soils, Infiltration Bed, Pervious Pavement

Rain barrels, and Cisterns

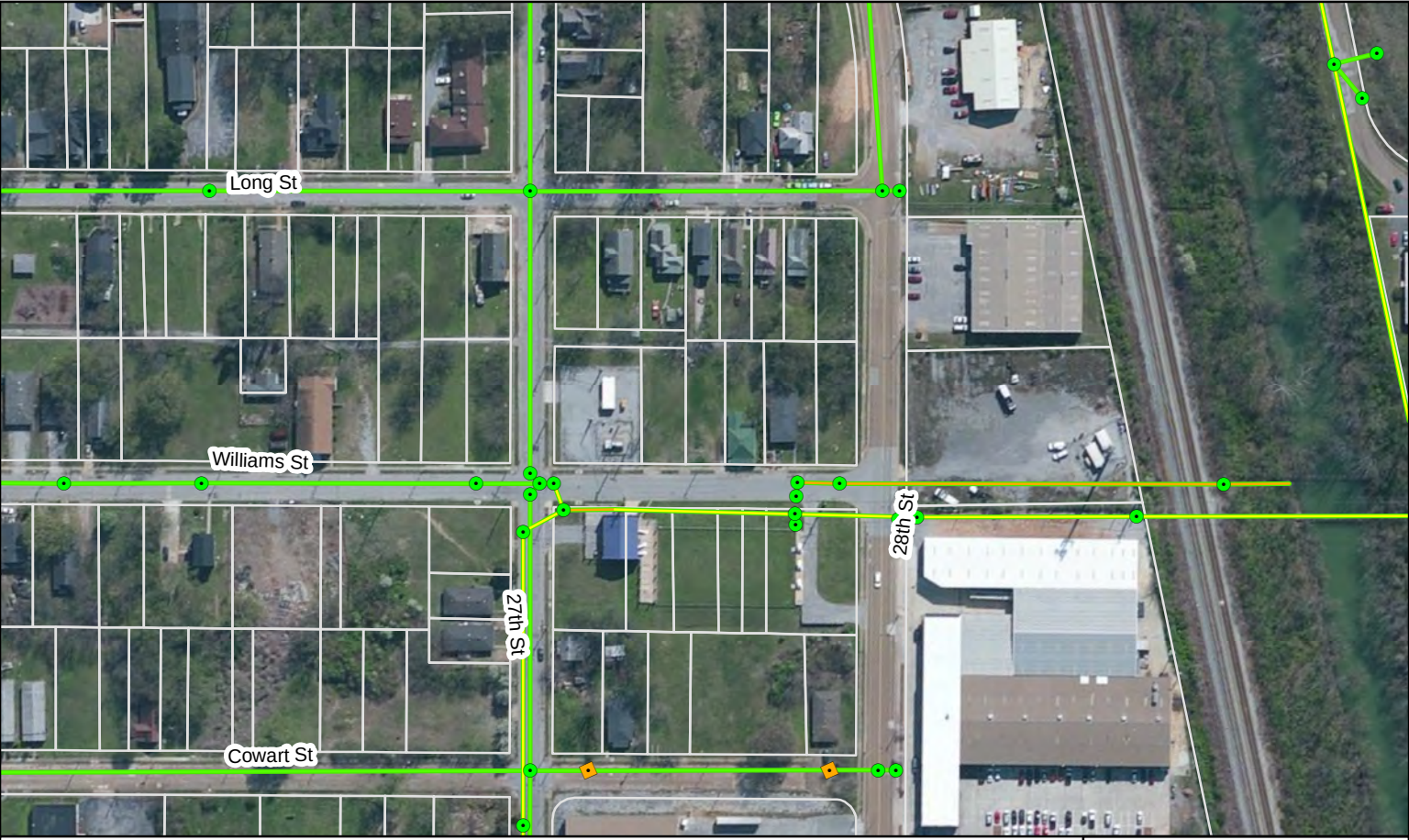
Technical constraints

This site contains a CSOTF. The site could use streetscape or additional drainage improvements for the implementation of GI.

Visual social constraints/benefits

The site has low social benefit. It could greatly benefit from the addition of social benefit improvements such as sidewalks, green space or improved tree cover.

Summary Notes: The space for the implementation of GI is limited. The existing social benefit is low and the site has a fair potential to manage run-off from upland areas (assuming the street and ROW were included in available space). Most probable application would be the implementation of rain barrels or cisterns to manage existing building and streetscape modifications.



City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: Williams Street (27th Street to 28th Street)

Manholes
Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 50 100 200
Feet

Field Assessment

Potential GI Project	**Site #10 Howard School & I-24 Corridor**
CSS Basin	**5**
Location	**320 E. 25th Street**
Surrounding Area	**Suburban**

Feasibility

Recommended BMP application

Large site, I-24 sits above site, recommended BMP would be constructed wetlands, infiltration trenches, infiltration beds, and bio-retention. Additionally, Howard School is located adjacent to this site and the site could be used to manage run-off from upland areas located at the school.

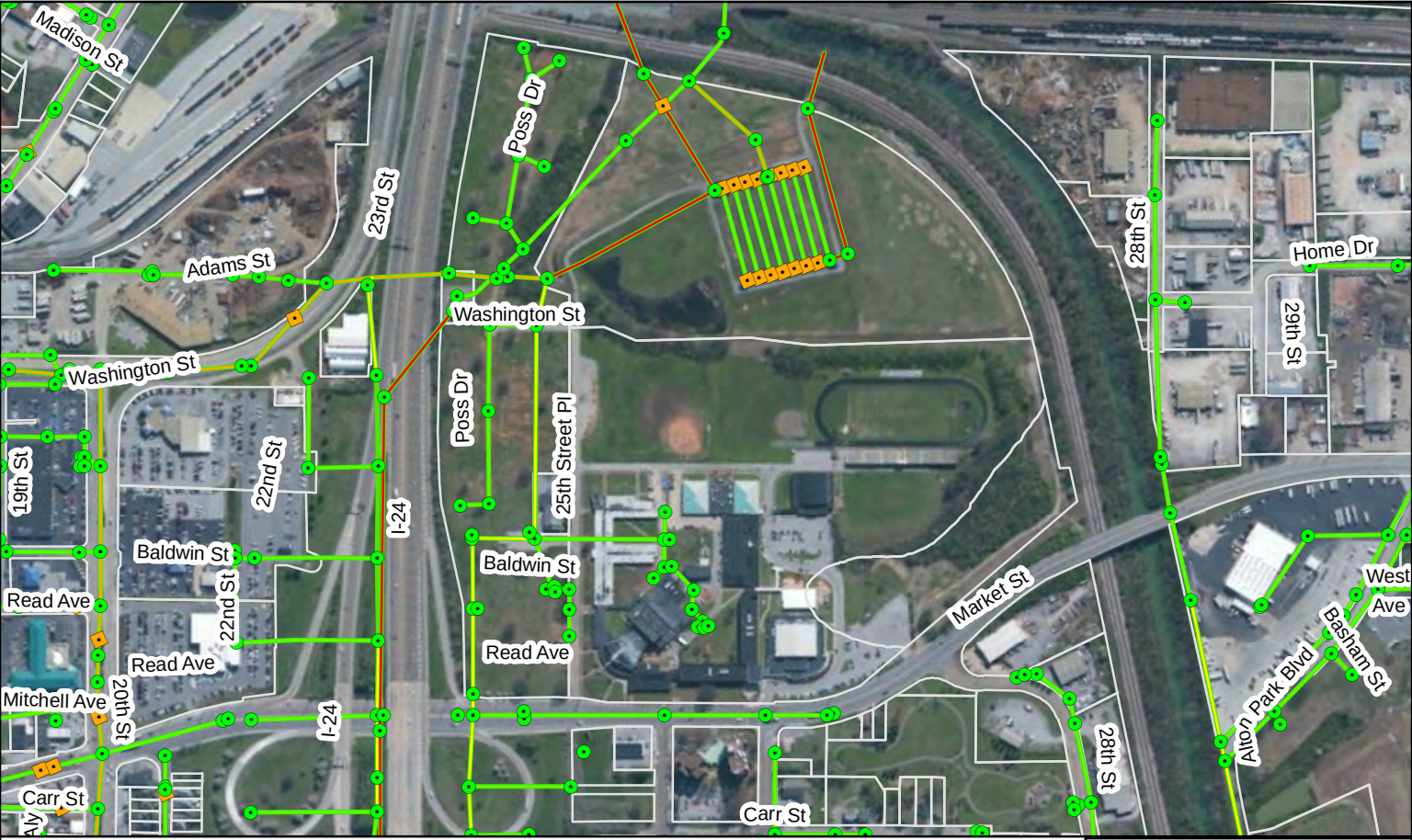
Technical constraints

Site is very large and already has a heavy vegetative cover. Site is very flat with some low areas. The site may not have soils to allow for infiltration in some locations on the site. Existing pump stations and other utilities will have to be accounted for when siting GI controls at the site.

Visual social constraints/benefits

Site is directly adjacent to school. School could be brought into site. This would allow for a larger selection of GI controls to be installed, provide education and outreach benefits for allowing students to maintain BMP's, and a "lab" for use by teachers to illustrate hydrology, soils and other topics. Site is very suitable for edible garden or sustainable garden.

Summary Notes: The site is very large, but it is broken up by elevation and the location of existing utilities. The site has ample area for the implementation of GI and has a high social benefit due to the opportunities provided by the Howard School adjacent to the site. The site has a good potential to manage run-off from upland areas where infiltration practices are suitable on site.



City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: Howard School & I-24 Corridor

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 150 300 600
Feet

Field Assessment

Potential GI Project	**Site #11 E 8th Street (Oneal to Central)**
CSS Basin	**8**
Location	**1237 8th Street**
Surrounding Area	**Suburban/Urban**

Feasibility

Recommended BMP application

Infiltration Trench, Pervious Pavement, Infiltration Bed, Increase Tree Canopy.

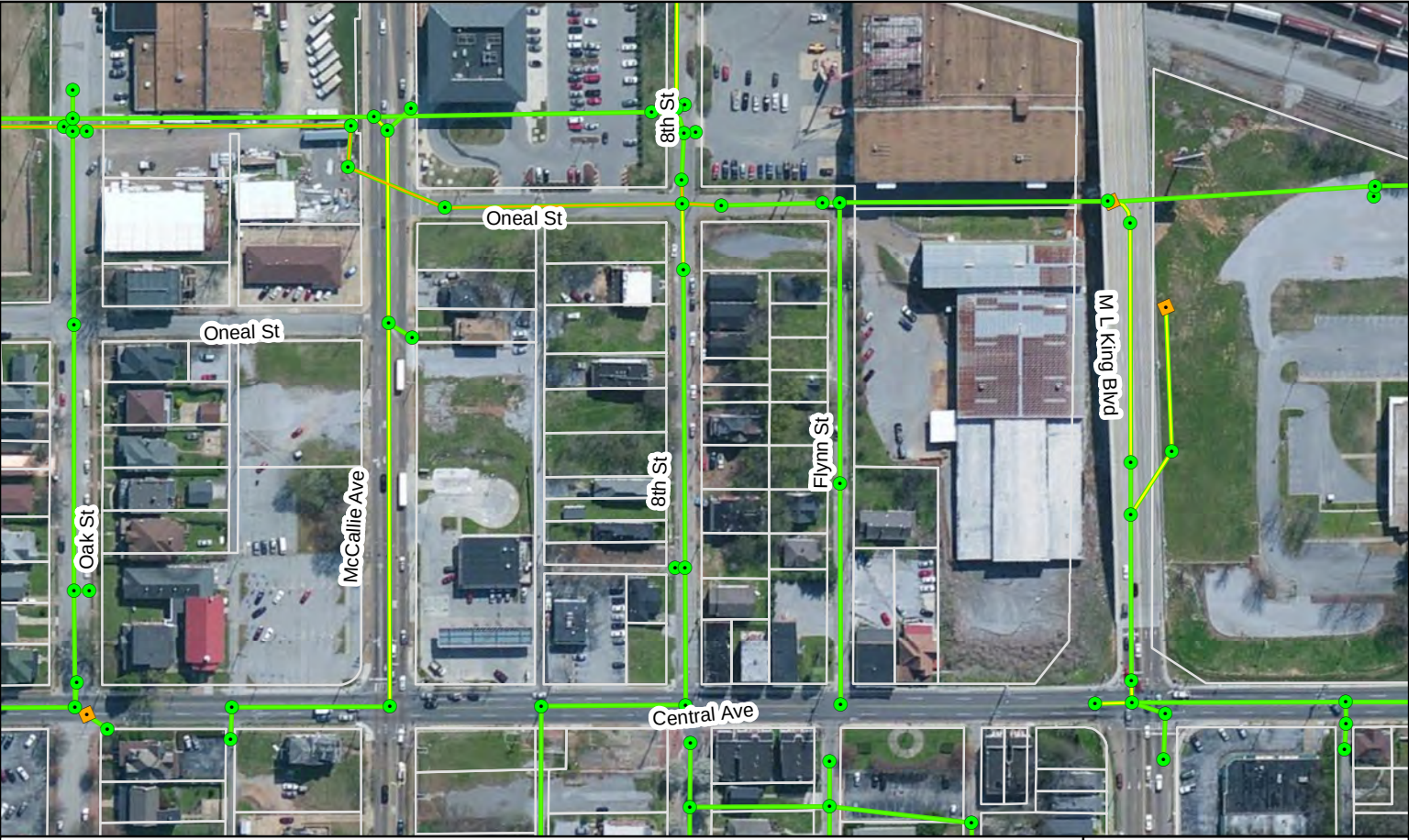
Technical constraints

Site is small, but at the bottom of hill so it could have large effect by providing infiltration for offsite areas that drain to this site. This site could be combined with streetscape and area drainage improvements. Additionally, this could be combined with possible projects located at the end of the block, on EPB properties, to enhance the impact of GI implementation at this location.

Visual social constraints/benefits

No constraints. No existing benefits. GI controls and street scape modifications could be used to combine with neighborhood revitalization efforts as part of other City programs.

Summary Notes: The site is located below a hill. It is possible that this site could be clustered with adjacent EPB properties to improve the impact of GI controls at this location. The site has limited space for GI implementation and low social impact but presents a good opportunity to manage run-off from upland areas.



City of Chattanooga
Green Infrastructure Plan

Manholes
Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 50 100 200
Feet

Site Assessment Map: East 8th Street (Oneal St. to Central Ave.)

Field Assessment

Potential GI Project	**Site #12 – 274 E. 10th Street**
CSS Basin	**6**
Location	**274 E. 10th Street**
Surrounding Area	**Downtown, Commercial**

Feasibility

Recommended BMP application

Increase Tree Canopy, Infiltration Trench/Bed, Pervious Pavement, Green Roof, Cistern, Rain Barrel.

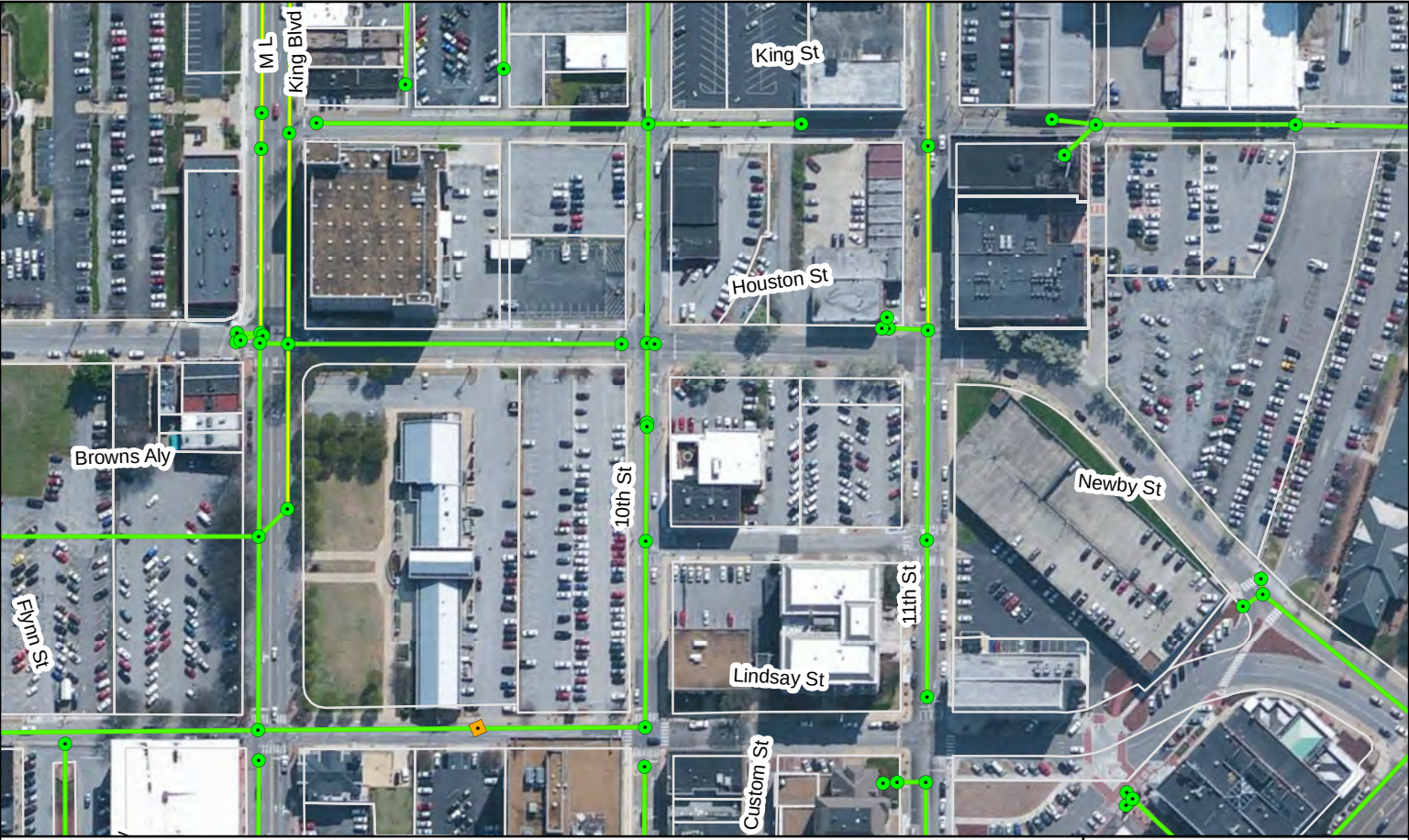
Technical constraints

The site itself is very small, with a flat roofed building. Because the site is downtown, there is a high potential for a large amount of utilities to consider while selecting potential GI controls. If combined with streetscape the location would be more viable for implementation of GI.

Visual social constraints/benefits

This could be combined with a streetscape where on street parking is converted to pervious pavement and or infiltration trenches are installed for localized drainage control. However, the existing site and building would provide little social benefit.

Summary Notes: Site is very small. Space is limited and the social value is low. There is no opportunity to manage run-off from upland areas at this location. It is recommended that implementation at this site be combined or clustered with nearby sites and streets to increase the feasibility of GI at this location.



City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: 274 East 10th Street

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 50 100 200
Feet

Field Assessment

Potential GI Project	**Site #14 – 12th Street (Central Ave. to Park Ave.)**
CSS Basin	**6**
Location	**12th Street (Central Ave. to Park Ave.)**
Surrounding Area	**Suburban, Commercial**

Feasibility

Recommended BMP application

Increase Tree Canopy, Infiltration Trench/Bed, Pervious Pavement, Green Roof, Cistern, Rain Barrel.

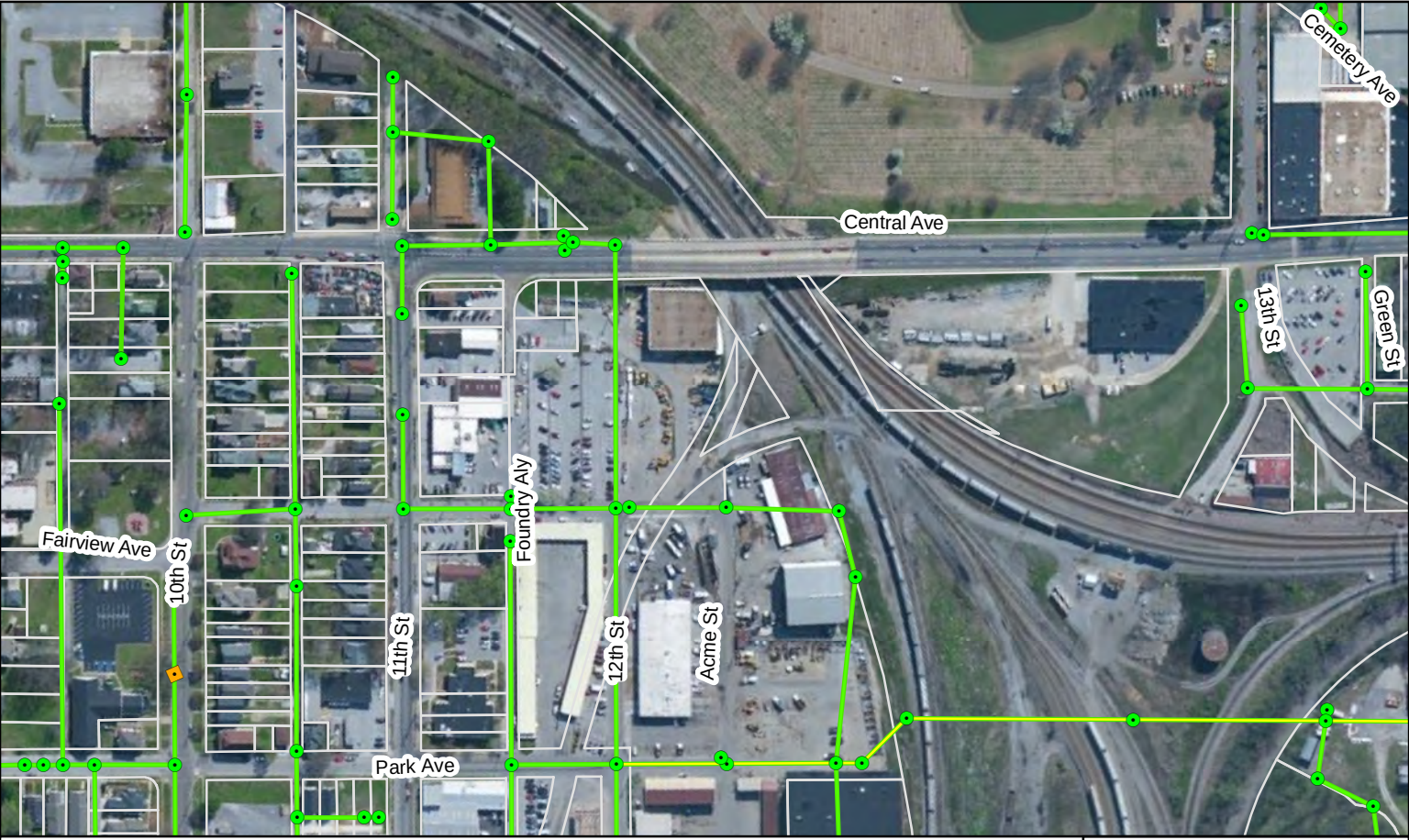
Technical constraints

The site is large and consists of the fleet services maintenance and fueling building, as well as 12th Street from Central Ave to Park Ave. This site has adequate space for GI implementation, however, a detailed environmental assessment and spill prevention plan would have to be implemented prior to siting GI controls at this location.

Visual social constraints/benefits

The site has little social benefit to the public; however, it is very visible to City staff and maintenance crews. It would be very beneficial to City staff for the practical application and maintenance of GI controls.

Summary Notes: Site is very large and applicable to a wide array of GI controls. Due to fueling and maintenance operations, additional planning steps, analysis, and considerations are required before siting and selecting GI controls for this location.



City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: 12th Street (Central Ave. to Park Ave.)

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 75 150 300
Feet

Field Assessment

Potential GI Project	**Site #19 – Chattanooga Housing – Grove Street**
CSS Basin	**1**
Location	**Chattanooga Housing Grove Street**
Surrounding Area	**Urban**

Feasibility

Recommended BMP application

Increase Tree Canopy, Infiltration Trench/Bed, Pervious Pavement, Cistern, Rain Barrel, Rain Garden

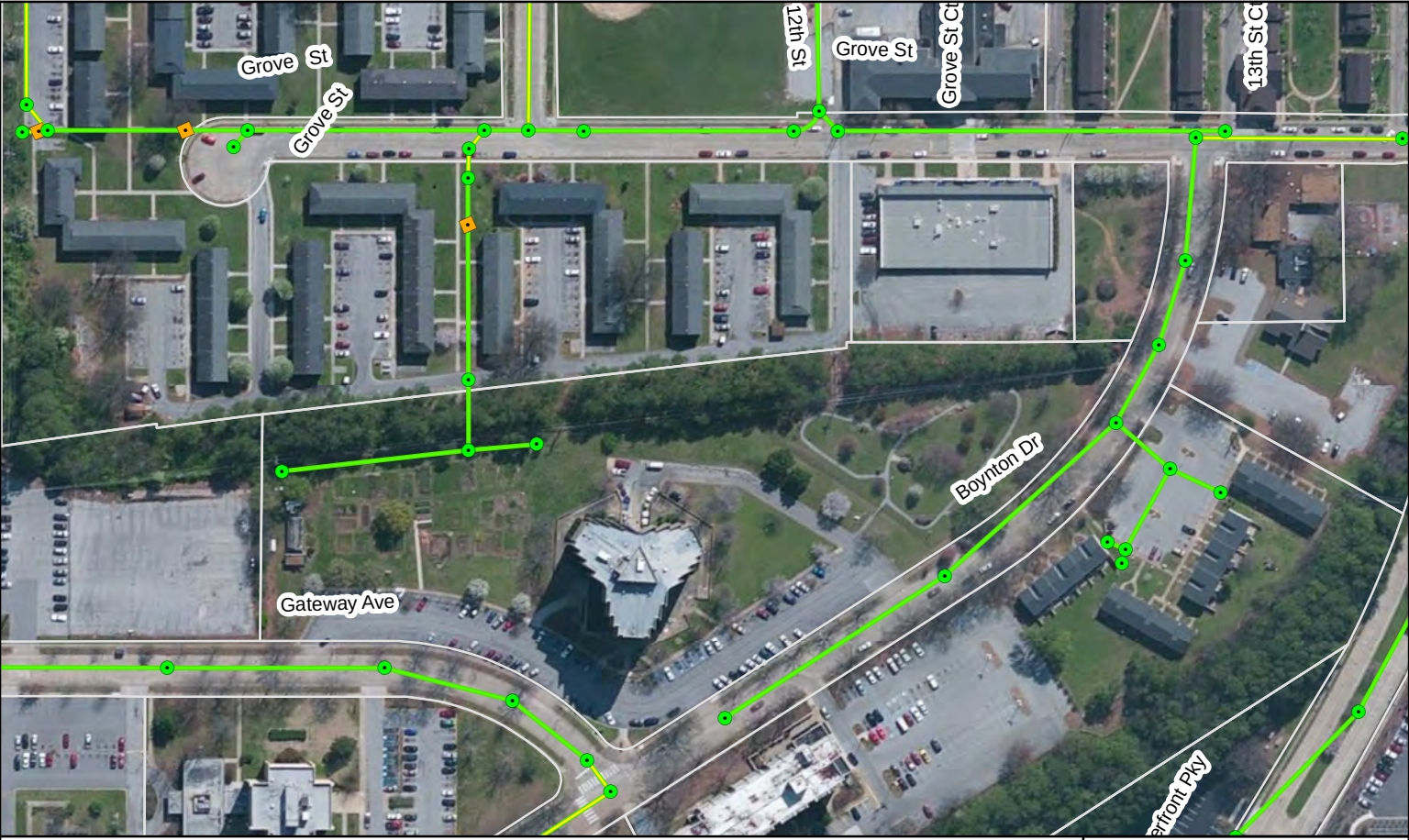
Technical constraints

The site is large and consists of the local streets and government housing. This site has space for GI implementation. Additionally, there is a community garden where captured water could be reused for irrigation.

Visual social constraints/benefits

The site has a high social benefit due the educational component available by utilizing GI in an area where low impact, low cost solutions could be integrated to assist with managing run-off from portions of the site or individual buildings.

Summary Notes: Site is very large and applicable to a wide array of GI controls. The site has good space available for the implementation of GI, a high social benefit, and has the ability to manage run-off from upland areas.



City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: Chattanooga Housing

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

N

0 50 100 200

Feet

Field Assessment

Potential GI Project	**Site #20 – 2502 Long Street**
CSS Basin	**4**
Location	**2502 Long Street**
Surrounding Area	**Urban**

Feasibility

Recommended BMP application

Infiltration Trench, Infiltration Bed, Increase Tree Canopy, Bioretention

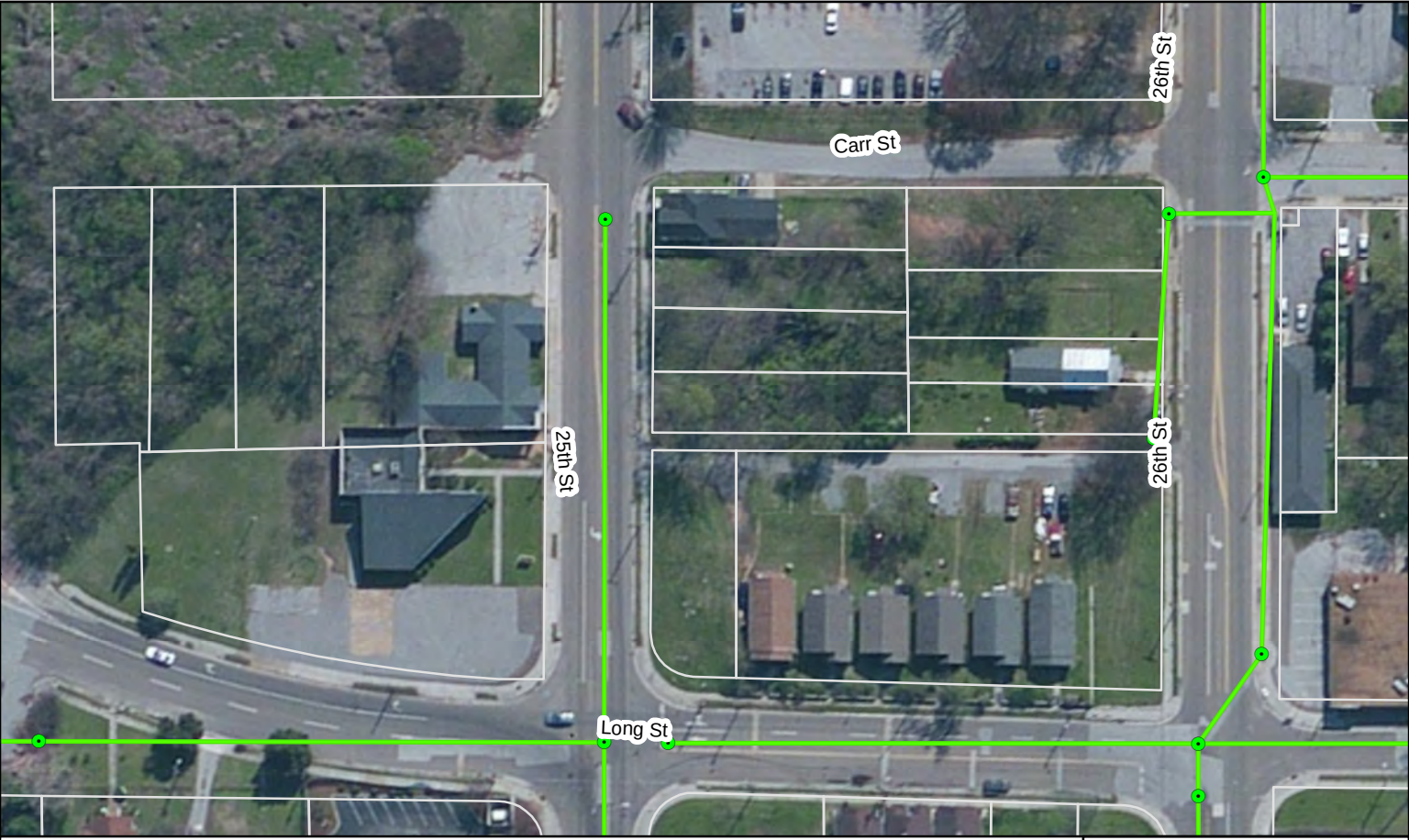
Technical constraints

The site is located on a regional high point. Impervious cover is approximately 10%. Existing sidewalks located along the northwest (Long Street) and northeast (25th Street) sides of the site were constructed using standard methods. There is an existing retaining wall located along the Long Street sidewalk. Southeast side of the site is bordered by an alleyway.

Visual social constraints/benefits

Very close to existing residence on southwest side of site.

Summary Notes: The site is very small and has limited space. The social benefit is limited and the site has no ability to capture or manage run-off from upland areas.



City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: 2502 Long Street

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 25 50 100
Feet

Field Assessment

Potential GI Project	**Site #22 – 505 E. MLK Boulevard**
CSS Basin	**1**
Location	**505 E. MLK Boulevard**
Surrounding Area	**Urban**

Feasibility

Recommended BMP application

Increase Tree Canopy, Infiltration Bed, Infiltration Trench, Bioretention,

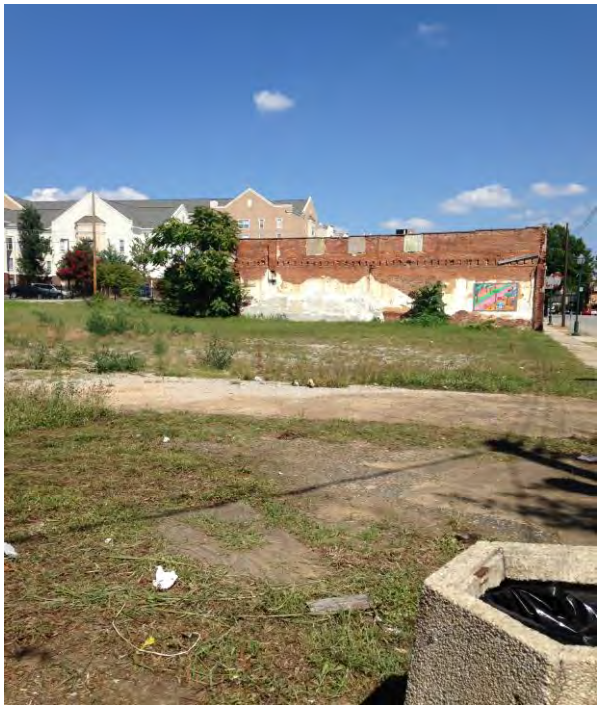
Technical constraints

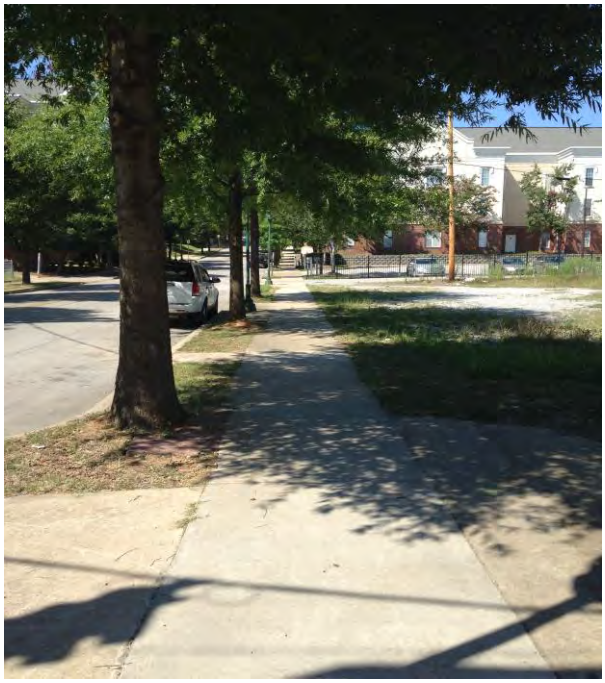
None apparent technical constraints. The site is located downhill of a large impervious drainage area. Site is adjacent to an existing storm sewer along E. MLK Boulevard.

Visual social constraints/benefits

Site is located near downtown area in an area of revitalization.

Summary Notes: This site has the potential to provide social benefit if open space is connected to pedestrian access and includes elements designed to enhance pedestrian access to green spaces. The site has a fair social value due to location. The size is limited but has good potential to capture and treat run-off from upland areas.





City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: 505 MLK Blvd

Manholes
Storm Inlets

Gravity Sewer Lines

4" - 15" Diameter
18" - 30" Diameter
36" - 60" Diameter
66" - 120" Diameter
Parcel Boundary

0 25 50 100
Feet

Field Assessment

Potential GI Project	**Site #23 – UTC Campus**
CSS Basin	**6 & 8**
Location	**UTC Campus**
Surrounding Area	**Urban/Commercial/Suburban**

Feasibility

Recommended BMP application

Increase Tree Canopy, Infiltration Bed, Infiltration Trench, Bioretention, Pervious Pavement, Cistern, Amend/Restore Soils

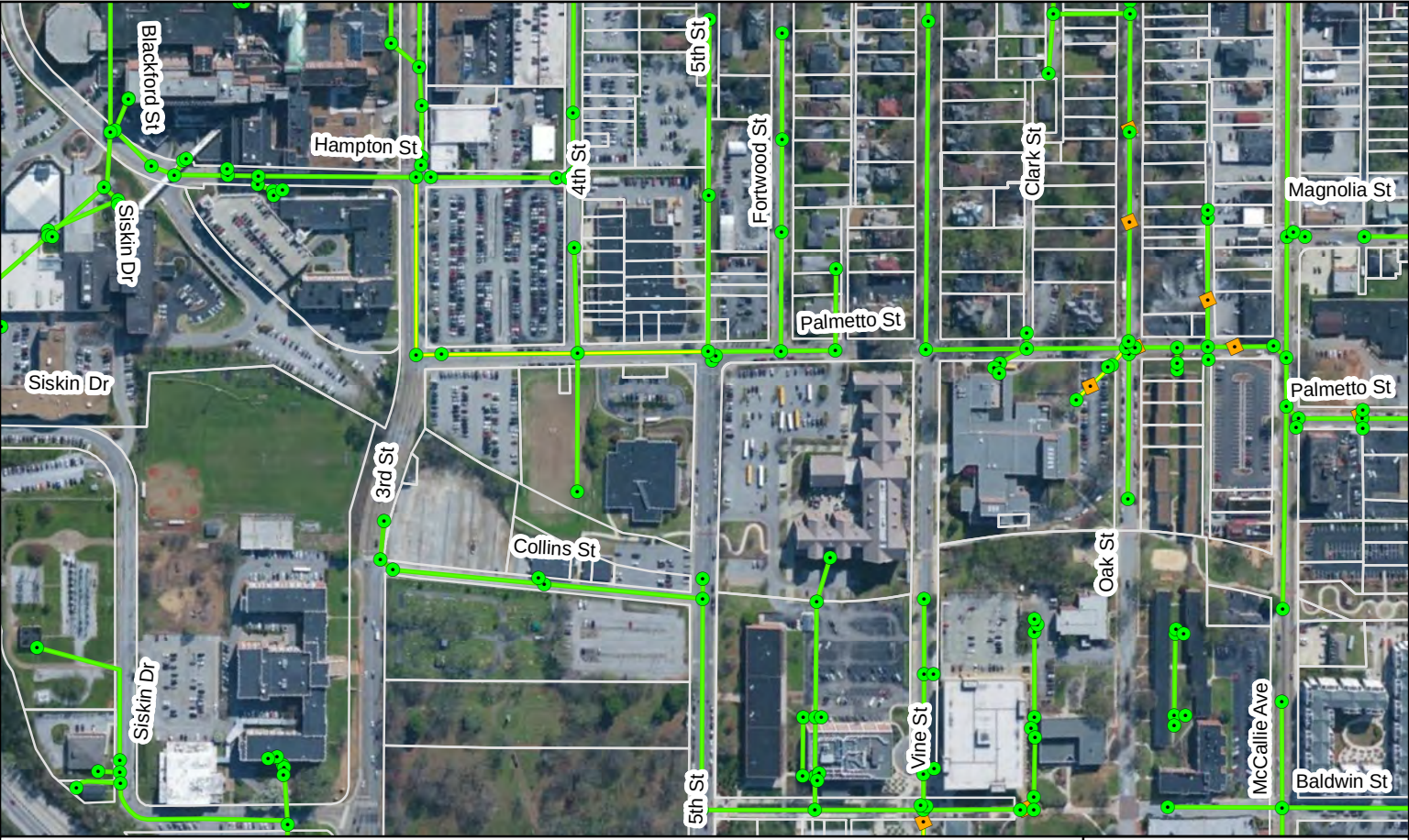
Technical constraints

This site is very large and contains a large number of utilities. Implementation should be integrated in the UTC Master Plan, existing greenway, and future greenway.

Visual social constraints/benefits

There are no social constraints. Social benefit is high due to current use as college campus.

Summary Notes: This site has the potential to provide high social benefit and educational benefits. The site has a high social value due to current use and has good potential to capture and treat run-off from upland areas.



City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: UTC

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 100 200 400
Feet

Field Assessment

Potential GI Project	**Site #24 – Engel Stadium Parking Lot**
CSS Basin	**8**
Location	**518 Oneal Street**
Surrounding Area	**Urban/Suburban**

Feasibility

Recommended BMP application

Increase Tree Canopy, Pervious Pavement, Infiltration Bed, Infiltration Trench

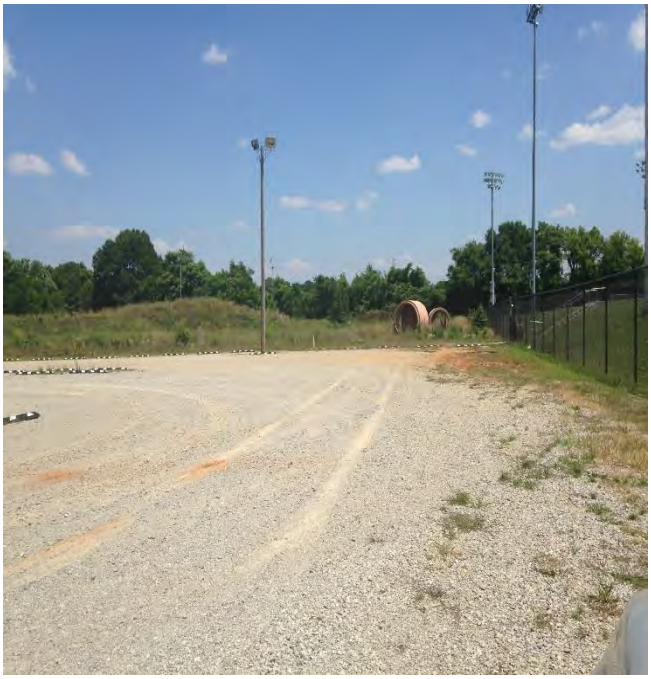
Technical constraints

Large hard-packed gravel parking lot.

Visual social constraints/benefits

Several residences are located along the west side of Oneal Street across from the parking lot. Green infrastructure would provide the opportunity for neighborhood beautification. UTC will begin playing baseball at the stadium and the parking lot is a student parking lot. GI Implementation would be highly visible at this location.

Summary Notes: This site has the potential to provide social benefit due to student use and during sporting events. The site has good social value due to use and location, ample space is available, and the site has good potential to capture and treat run-off from upland areas.



City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: Engel Stadium

Manholes
Storm Inlets

Gravity Sewer Lines

4" - 15" Diameter
18" - 30" Diameter
36" - 60" Diameter
66" - 120" Diameter
Parcel Boundary

0 50 100 200
Feet

Field Assessment

Potential GI Project	**Site #27 – Brown International Academy**
CSS Basin	**6**
Location	**701 E. MLK Blvd. / 718 E. 8th Street**
Surrounding Area	**Urban**

Feasibility

Recommended BMP application

Increase Tree Canopy, Pervious Pavement, Infiltration Bed, Infiltration Trench

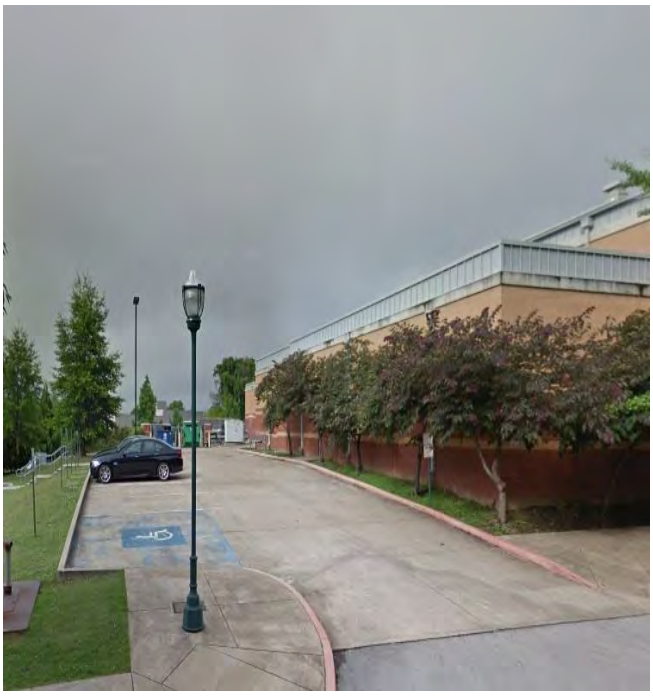
Technical constraints

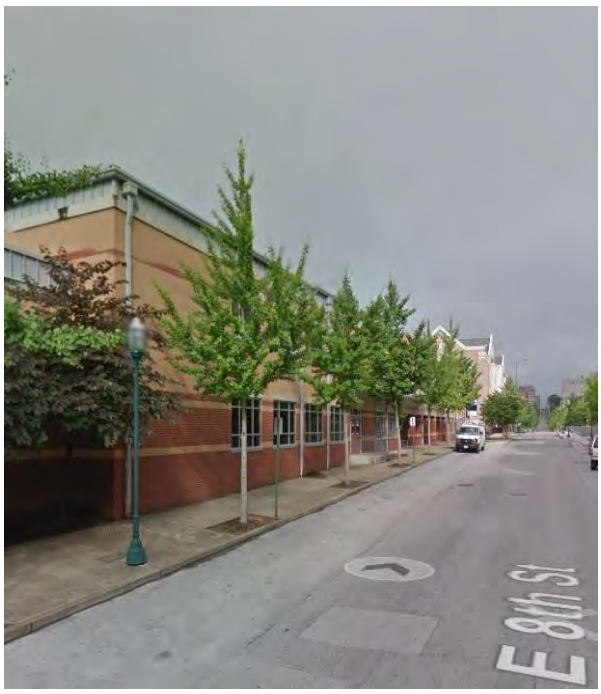
The majority of this site consists of buildings and a restricted playground area. Areas that are open to public access are existing sidewalks along E. MLK Boulevard and 8th Street, and driveways and loading areas. There is a large parking lot along the greenway that has potential and the site has fair potential to capture and treat run-off from upland areas.

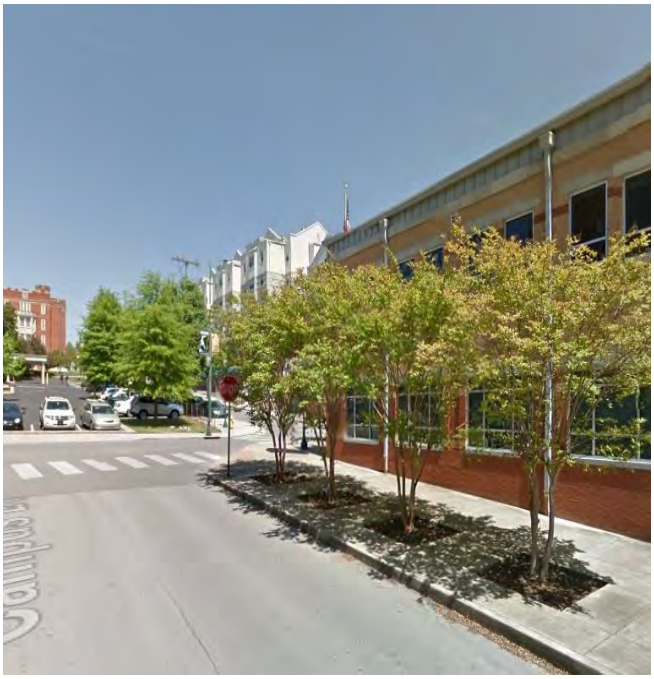
Visual social constraints/benefits

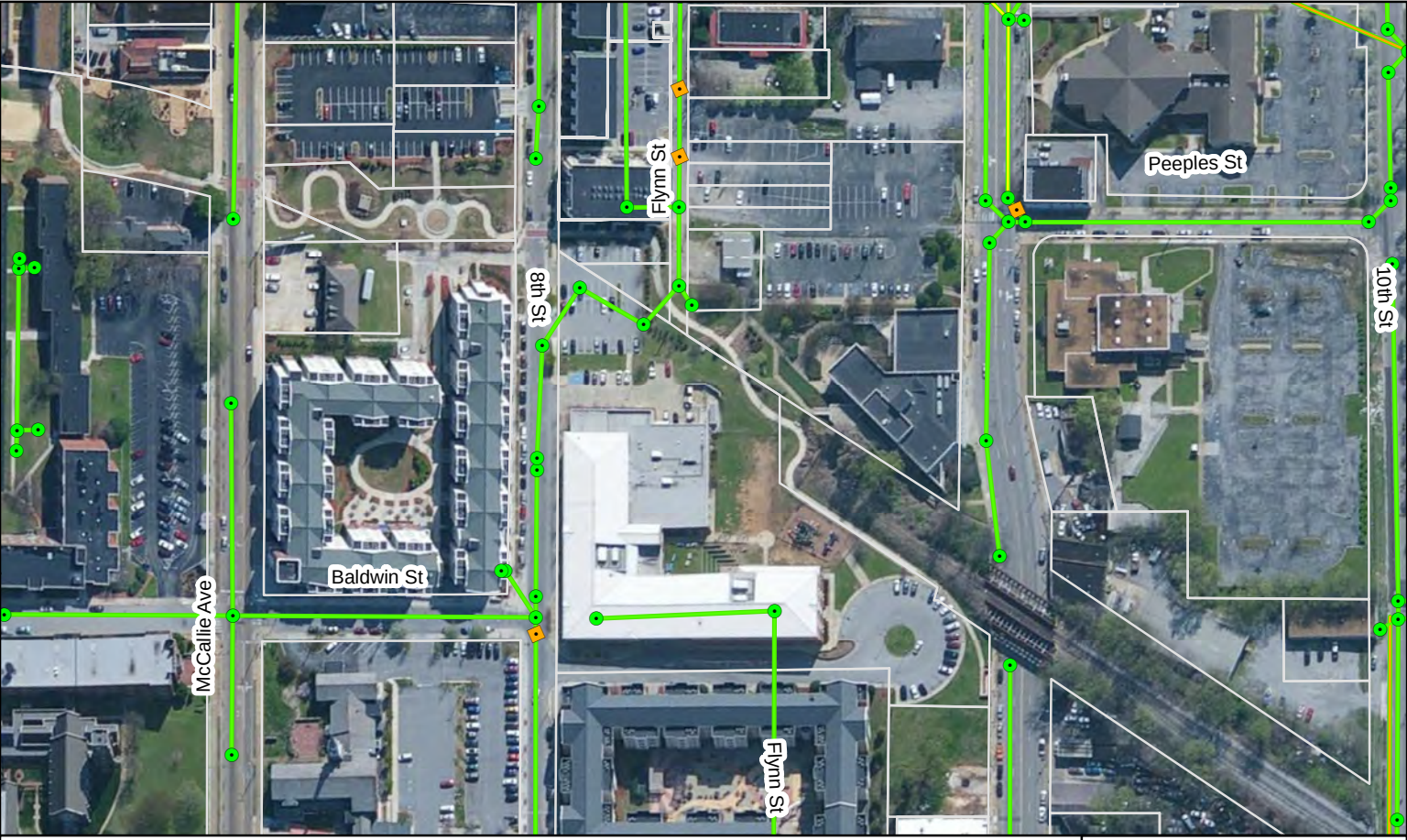
High social benefit due to location along greenway and use as school.

Summary Notes: This site has the potential for to provide social benefit due to current student use and location along greenway. The site has limited space, but it has fair potential to capture and treat run-off from upland areas.









City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: Brown International Academy

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 50 100 200
Feet

Field Assessment

Potential GI Project	**Site #30 – EPB Vicinity of 1401 E. 5th Street**
CSS Basin	**8**
Location	**Vicinity of 1401 E. 5th Street**
Surrounding Area	**Industrial/Urban/Suburban**

Feasibility

Recommended BMP application

Increase Tree Canopy, Pervious Pavement, Infiltration Bed, Infiltration Trench

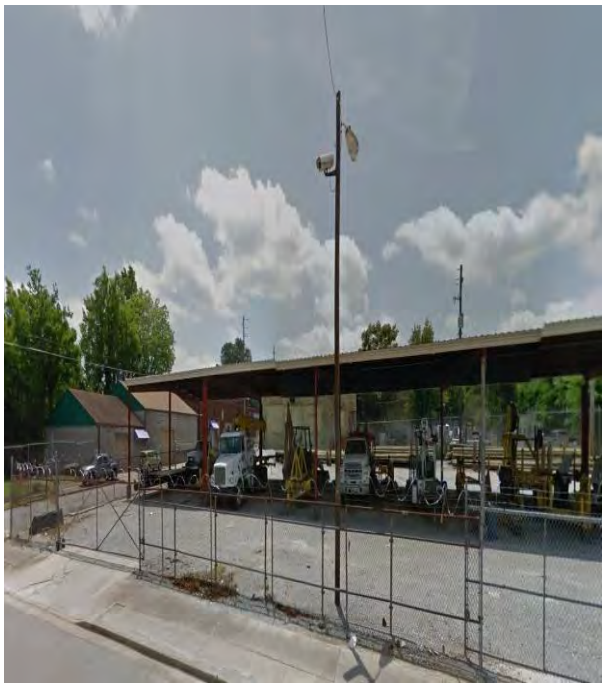
Technical constraints

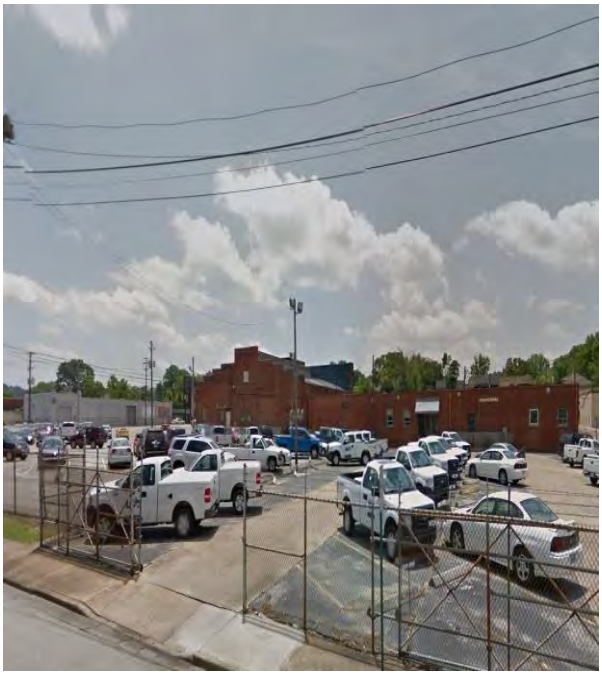
The site is currently a storage, laydown and operations yard for the Electric Power Board. An environmental assessment and spill prevention plan would be required prior to siting GI controls at this location. Additionally, there is a large number of buildings and utilities to consider.

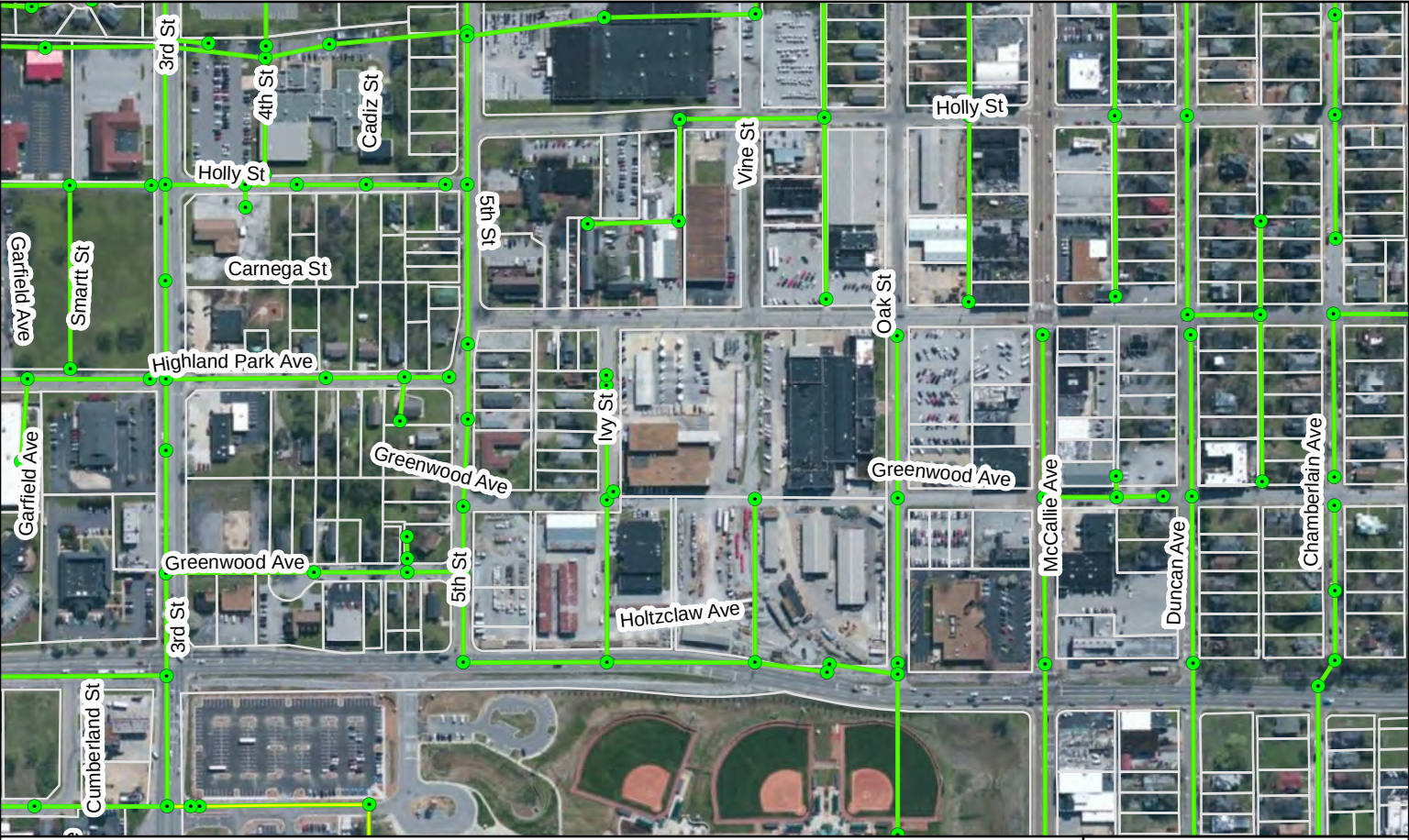
Visual social constraints/benefits

Visual and social benefit would be best provided by screening of this property with increased tree canopy, which would also reduce run-off from existing property.

Summary Notes: The site has poor social value due to existing use, has ample space, and the site has good potential to capture and treat run-off from upland areas.







City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: EPB (Vicinity of 1401 E. 5th Street)

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 100 200 400
Feet

Field Assessment

Potential GI Project	**Site #31 – Riverside Substation**
CSS Basin	**7**
Location	**911 Siskin Drive**
Surrounding Area	**Urban**

Feasibility

Recommended BMP application

Pervious Pavement, Infiltration Trench, Infiltration Bed

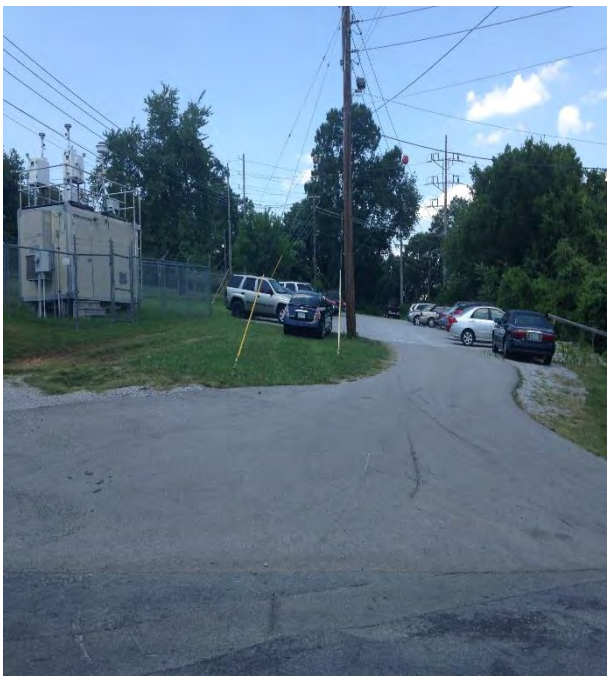
Technical constraints

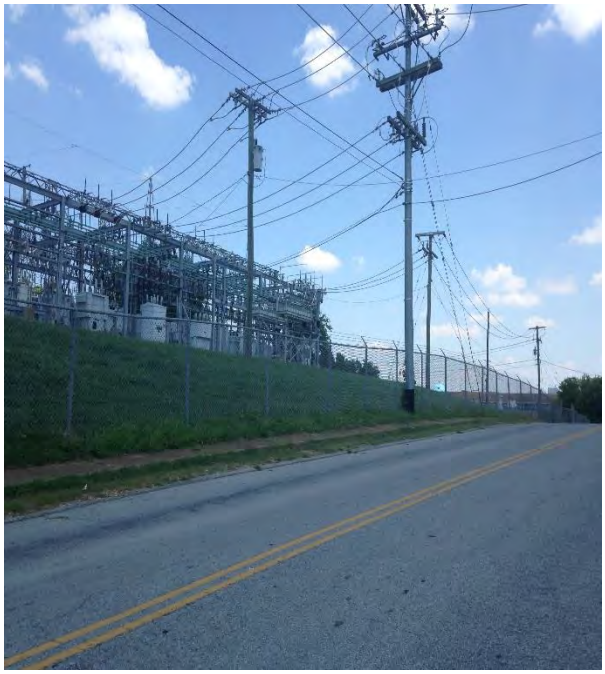
The site includes an electrical substation; consisting of the control building, transformers, power lines, driveway, fence, and gates. The site is situated on a hilltop with a small contributing drainage area. Much of the site consists of pervious cover (lawn and trees). Existing parking would be good location of GI controls to manage run-off from this site and upland areas.

Visual social constraints/benefits

The site is difficult to access and has low social benefit.

Summary Notes: The site has poor social value due to existing use and location. The site has good potential to capture and treat run-off from upland areas.





City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: 901 Siskin Dr.

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 50 100 200
Feet

Field Assessment

Potential GI Project	**Site #32 – Parking Lot at 1101 Broad Street**
CSS Basin	**8**
Location	**1101 Broad Street**
Surrounding Area	**Downtown**

Feasibility

Recommended BMP application

Pervious Pavement, Infiltration Bed, Cistern, Green Roof, Rain Barrel, Increase Tree Canopy

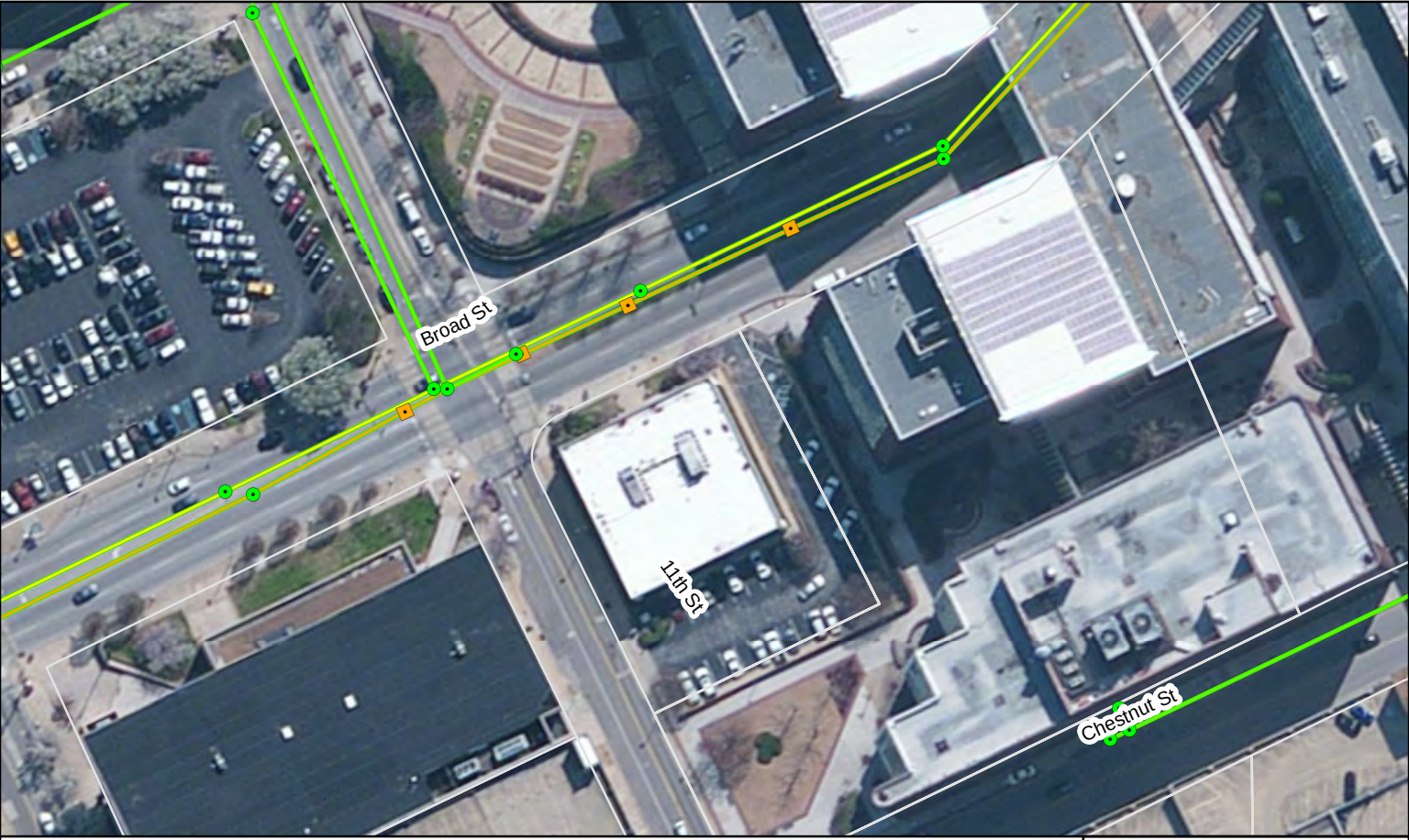
Technical constraints

Site consists of approximately 90% impervious area, including the roof of office building and paved parking lot. The site is bordered on the north by 11th Street and on the east by Broad Street.

Visual social constraints/benefits

The site has a fair social benefit due to location downtown.

Summary Notes: The site has fair social value due to its location. The site has fair potential to capture and treat run-off from upland areas (roofs, roof drains).



City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: 1101 Broad St.

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 25 50 100
Feet

Field Assessment

Potential GI Project	**Site #33 – UTC Parking Lot**
CSS Basin	**6**
Location	**843 E. 8th Street**
Surrounding Area	**Urban**

Feasibility

Recommended BMP application

Pervious Pavement, Infiltration Bed, Infiltration Trench, Increase Tree Canopy

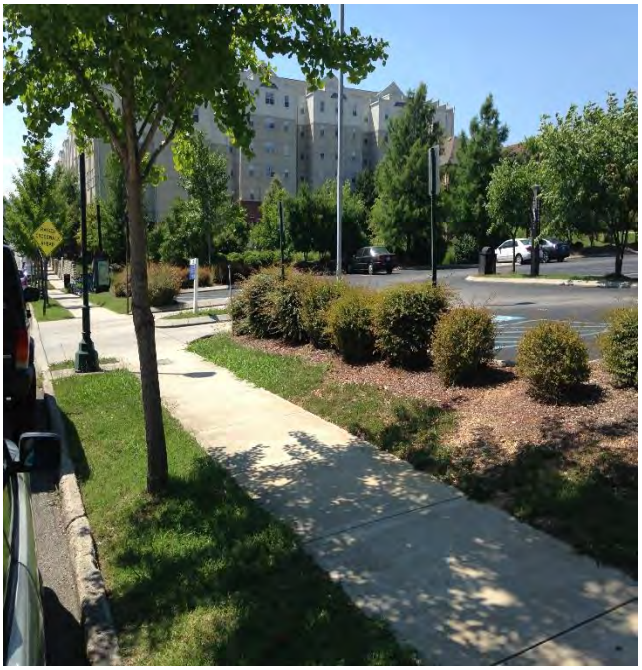
Technical constraints

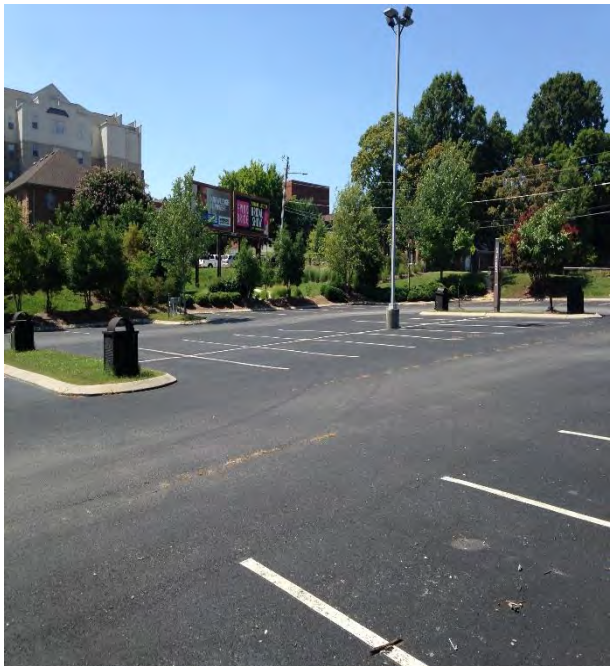
The site consists of a large paved asphalt parking lot. The lot slopes gradually from the north to the south. The existing pedestrian greenspace is located adjacent to the parking lot to the west.

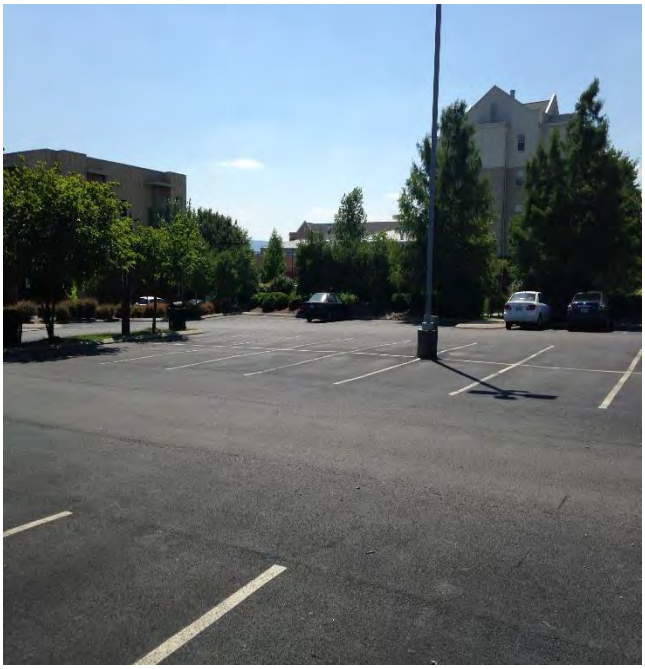
Visual social constraints/benefits

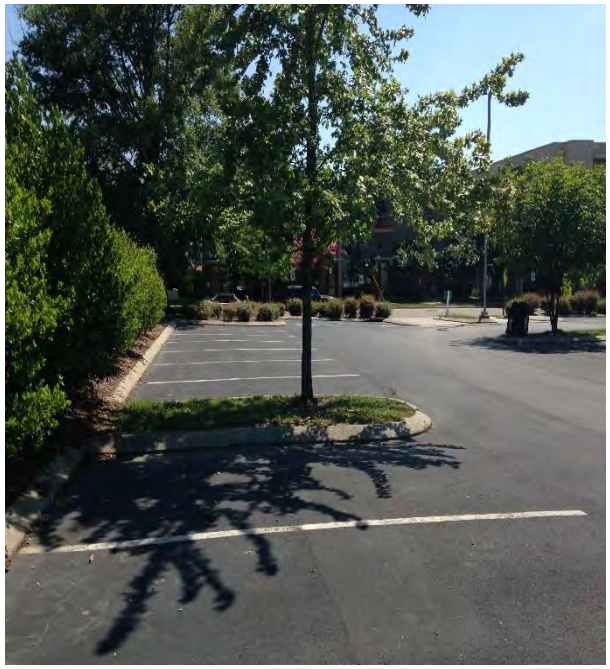
Located next to greenway.

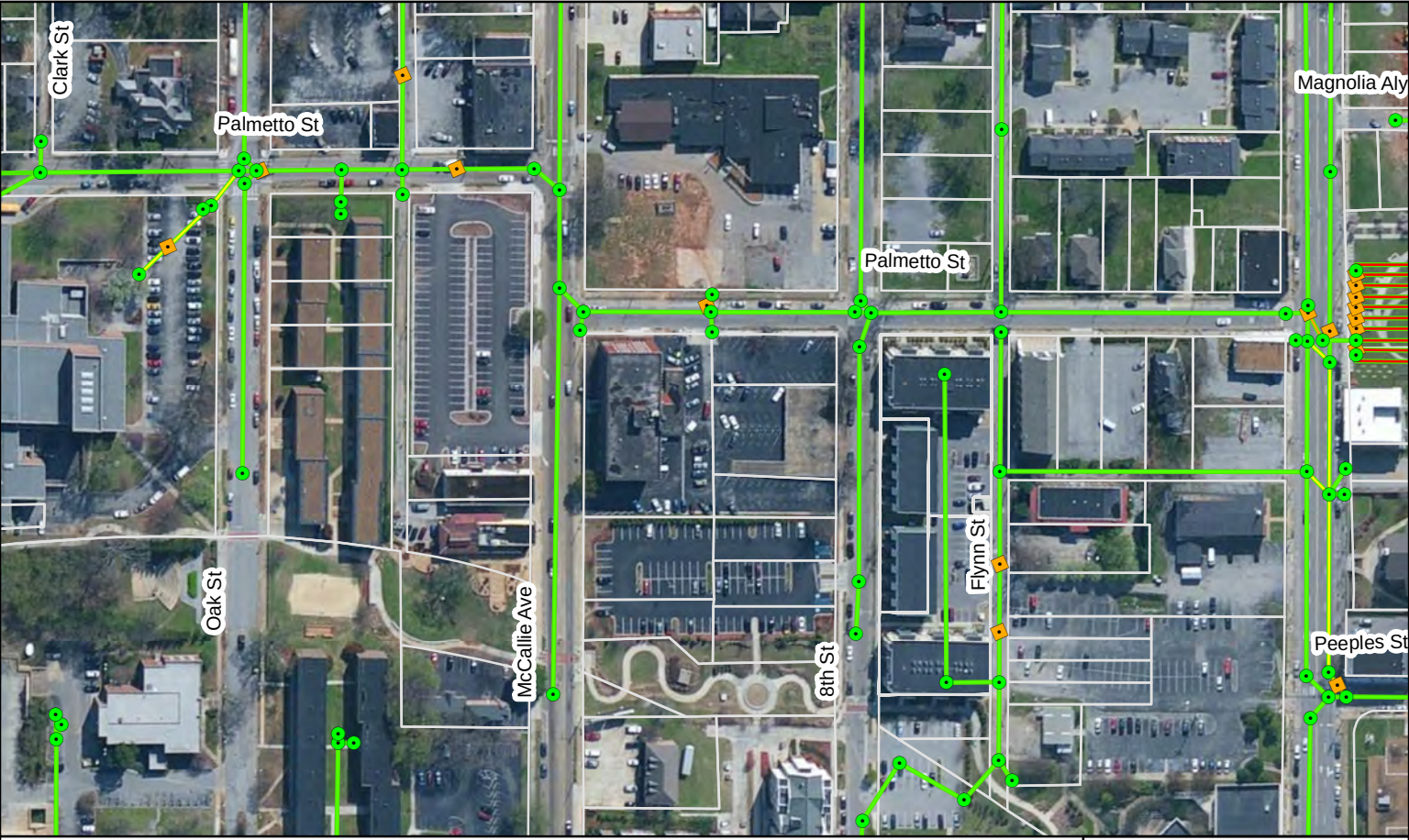
Summary Notes: The site has fair social value due to its location. The site has fair potential to capture and treat run-off from upland areas.











City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: 843 East 8th Street

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 50 100 200
Feet

Field Assessment

Potential GI Project	**Site #34 – African American Heritage Museum**
CSS Basin	**6**
Location	**200 E. MLK Blvd.**
Surrounding Area	**Downtown**

Feasibility

Recommended BMP application

Increase Tree Canopy, Pervious Pavement, Bioretention, Infiltration Bed, Infiltration Trenches, Cistern

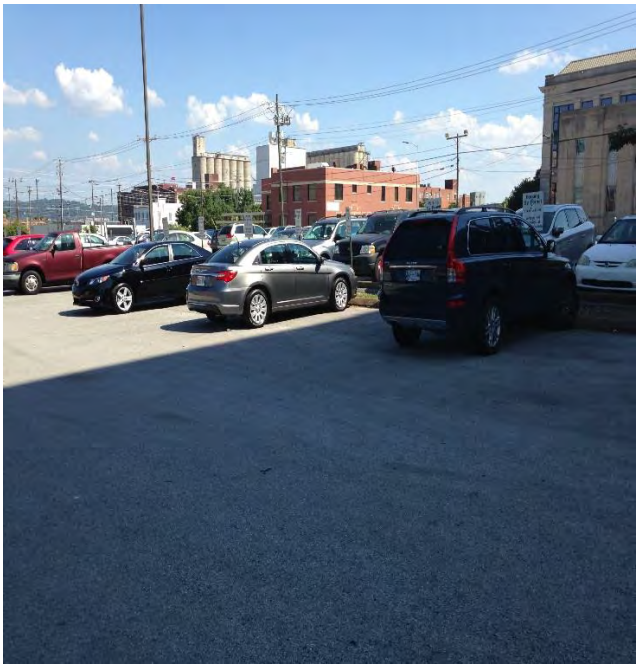
Technical constraints

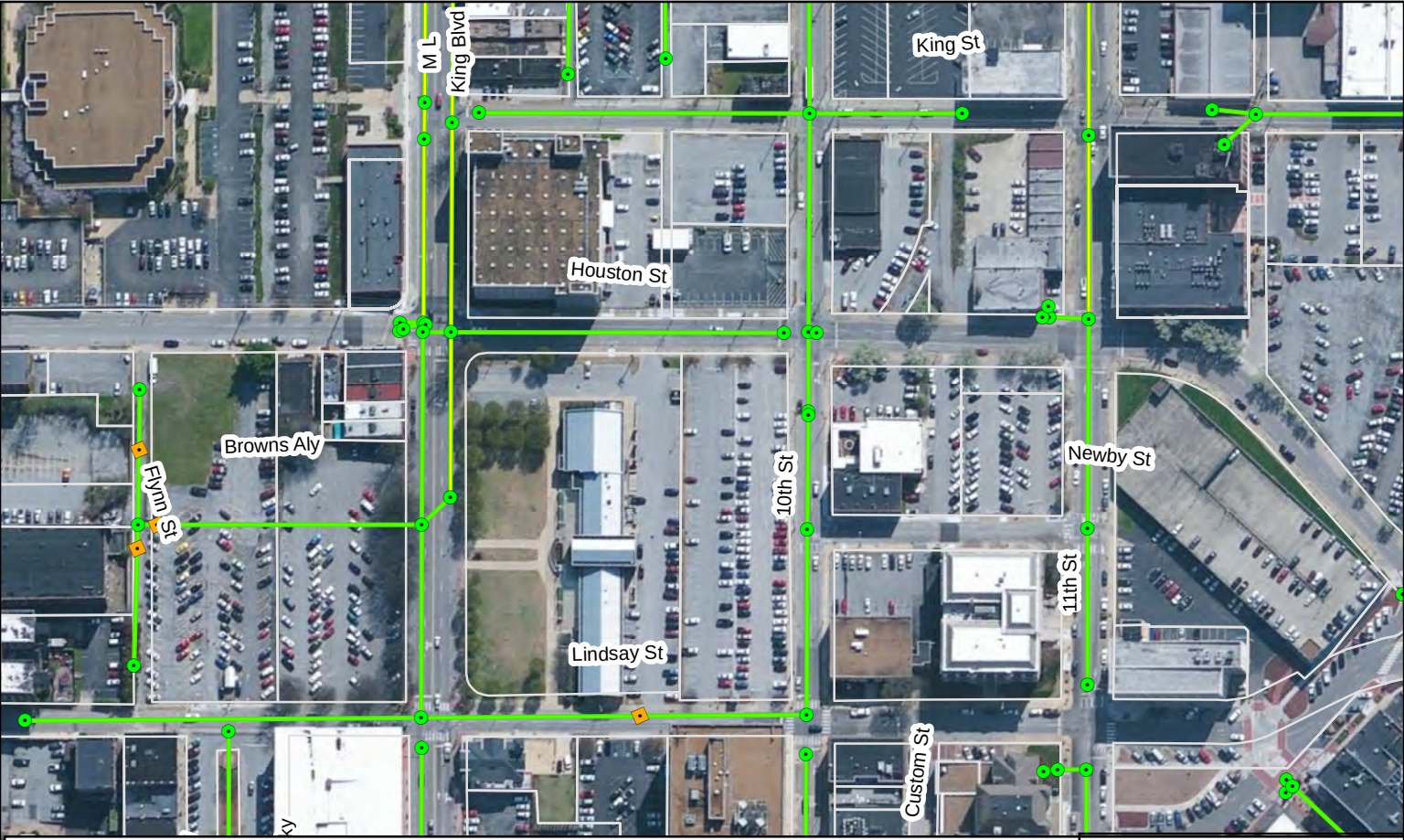
The site has a large existing paved parking lot in back of the building; however, it also has a large roof area that can be captured and it is adjacent to the storm drain system along MLK Blvd.

Visual social constraints/benefits

This site has great social benefits due to location downtown and use as museum.

Summary Notes: The site has good social value due to location and existing use. It has ample space. The site has fair potential to capture and treat run-off from upland areas.





City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: 200 East MLK Blvd

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

N

0 50 100 200
Feet

Field Assessment

Potential GI Project	**Site #35 – Parking lot at 225 E. 11th Street**
CSS Basin	**6**
Location	**225 E. 11th Street**
Surrounding Area	**Downtown/Urban**

Feasibility

Recommended BMP application

Pervious Pavement, Increase Tree Canopy, Infiltration Bed, Infiltration Trench

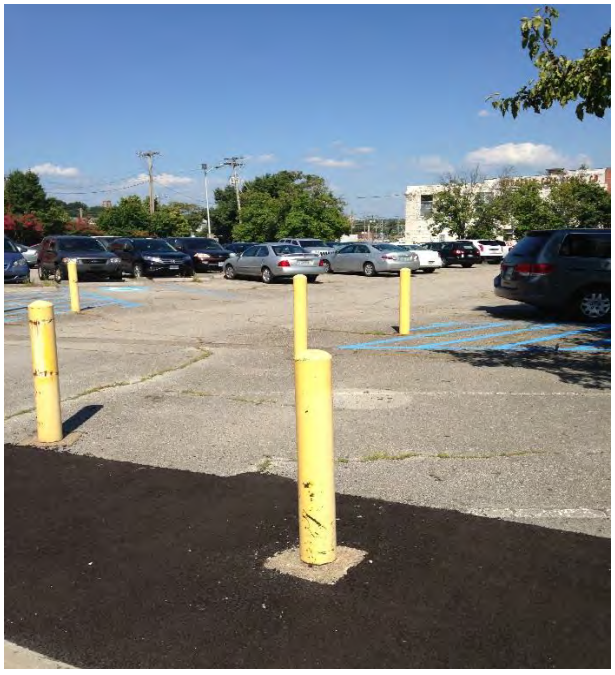
Technical constraints

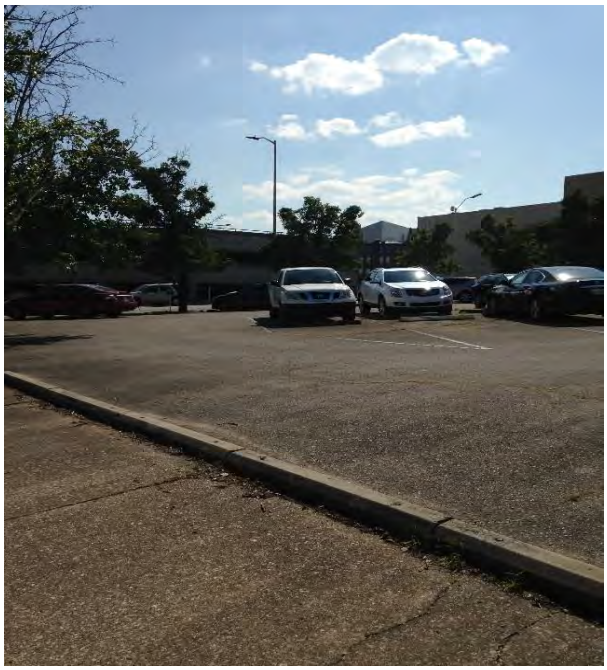
Siting of GI controls will require planning to coordinate with existing utilities and driveway entrances. However, the site could manage some run-off from upland areas.

Visual social constraints/benefits

Site is located downtown in a public parking lot. It is vdry visible, but would not provide social benefit beyond shaded pedestrian access, unless it was combined with other multi modal additions combined with streetscape.

Summary Notes: The site has fair social value due to location. It has ample space and it has fair potential to capture and treat run-off from upland areas.





City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: 225 East 11th Street

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 25 50 100
Feet

Field Assessment

Potential GI Project	**Site #36 – Parking lot at 901 E. 3rd Street**
CSS Basin	**8**
Location	**901 E. 3rd Street**
Surrounding Area	**Urban**

Feasibility

Recommended BMP application

Pervious Pavement, Increase Tree Canopy, Infiltration Bed, Infiltration Trench

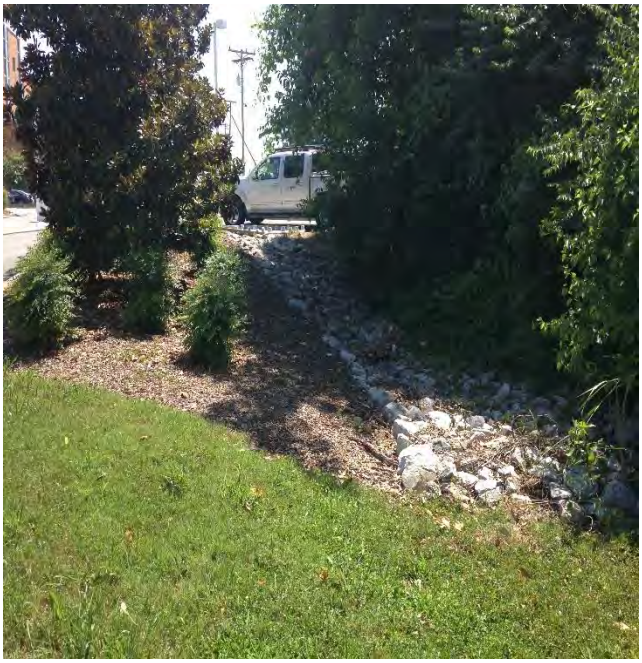
Technical constraints

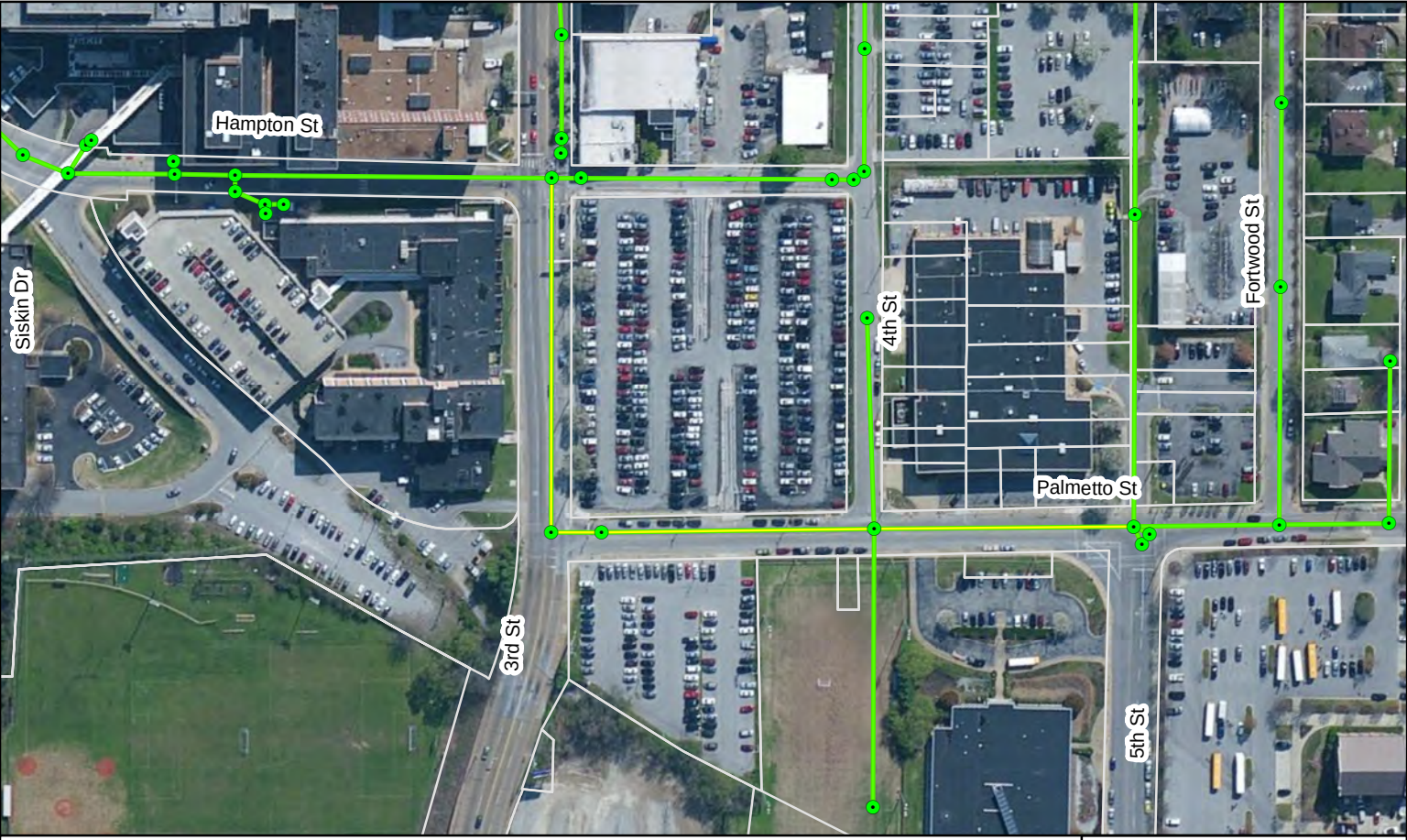
This site includes existing paved and gravel parking areas, existing storm sewer, and existing site lighting. However, the site is downhill from E. 3rd Street. It provides the opportunity for treatment of runoff from 3rd Street.

Visual social constraints/benefits

Site is located near campus, so GI implementation will be visible to students, staff and faculty.

Summary Notes: The site has fair social value due to location and it has good available space. The site has good potential to capture and treat run-off from upland areas.





City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: 901 East 3rd Street

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 50 100 200
Feet

Field Assessment

Potential GI Project	**Site #38 – AT&T Field Parking Lot**
CSS Basin	**2**
Location	**201 Power Alley**
Surrounding Area	**Downtown/Urban**

Feasibility

Recommended BMP application

Pervious Pavement, Infiltration Trench, Infiltration Bed, Increase Tree Canopy

Technical constraints

The site consists of existing paved parking lot and well-established, manicured lawn. The parking lot is downhill of AT&T Stadium so it provides the opportunity to treat stormwater runoff from impervious areas, including the parking lot and stadium roof.

Visual social constraints/benefits

Site has excellent social benefits due to events at the stadium and parking access to downtown attractions and events.

Summary Notes: The site has good social value due to location and existing use. It has very good available space, and the site has good potential to capture and treat run-off from upland areas.

City of Chattanooga
Green Infrastructure Plan

Site Assessment Map: 201 Power Alley

- Manholes
- Storm Inlets

Gravity Sewer Lines

- 4" - 15" Diameter
- 18" - 30" Diameter
- 36" - 60" Diameter
- 66" - 120" Diameter
- Parcel Boundary

0 50 100 200
Feet

Appendix H

Demonstration Projects

Demonstration Concepts

Concept plans are an integral part of rating and prioritizing potential projects. Development of a concept plan for potential projects will allow the City to identify the key elements of a potential project that may or may not allow for implementation of GI controls. Demonstration concept plans have been developed for four (4) potential project areas. The concept plans included were developed by estimating drainage areas within a concept area, analyzing the required capture volume using the RMG LID tool, selecting conceptual GI controls, determining the final GI control sizing using the RMG LID tool, and then drafting the demonstration concept plan.

The demonstration concepts will illustrate the process of developing a concept plan for use in rating of potential project for prioritization using the project rating tool. These designs are considered preliminary and not for construction use. Also, these concept plans provide only one particular option for GI implementation, other alternatives meeting performance objectives may be implemented.

Demonstration Concept 1: Central Avenue

GI Strategy:

Green Streets

GI Controls:

Change of Cover, Infiltration Practices, Pervious Pavement

Demonstration Concept Scope:

The Central Avenue project was developed from descriptions of the proposed widening of Central Avenue from TransPlan 2035. The latest version, TransPlan 2040 has replaced the proposed widening project with a study emphasizing community impacts of the project. For demonstration purposes, a concept was developed that includes a five lane section and new sidewalks. Additionally, the concept incorporates multi-modal elements. The concept demonstrates GI controls that may be implemented along Central Avenue to capture SOV. A cross section along the length of the existing section of Central Avenue between 3rd and 5th Streets has been chosen to represent this project location.

Concept Goals:

1. Increase plantings to meet 15% Tree Canopy Goal
2. 2.1" SOV

RMG Tool Input:

1. SOV Design Rainfall equals 2.1"
2. Total proposed impervious area approximately 635,100 s.f. This concept divided into two drainage areas for each side of right of way.
3. Rv = 0.85
4. Required SOV is approximately 89,091 cubic feet.
5. 269 trees per each side of road.
6. Proposed mid-height area for infiltration practices is equal to approximately 34,800 square feet.
7. 0.1" per hour infiltration rate assumed.

RMG Tool Summary

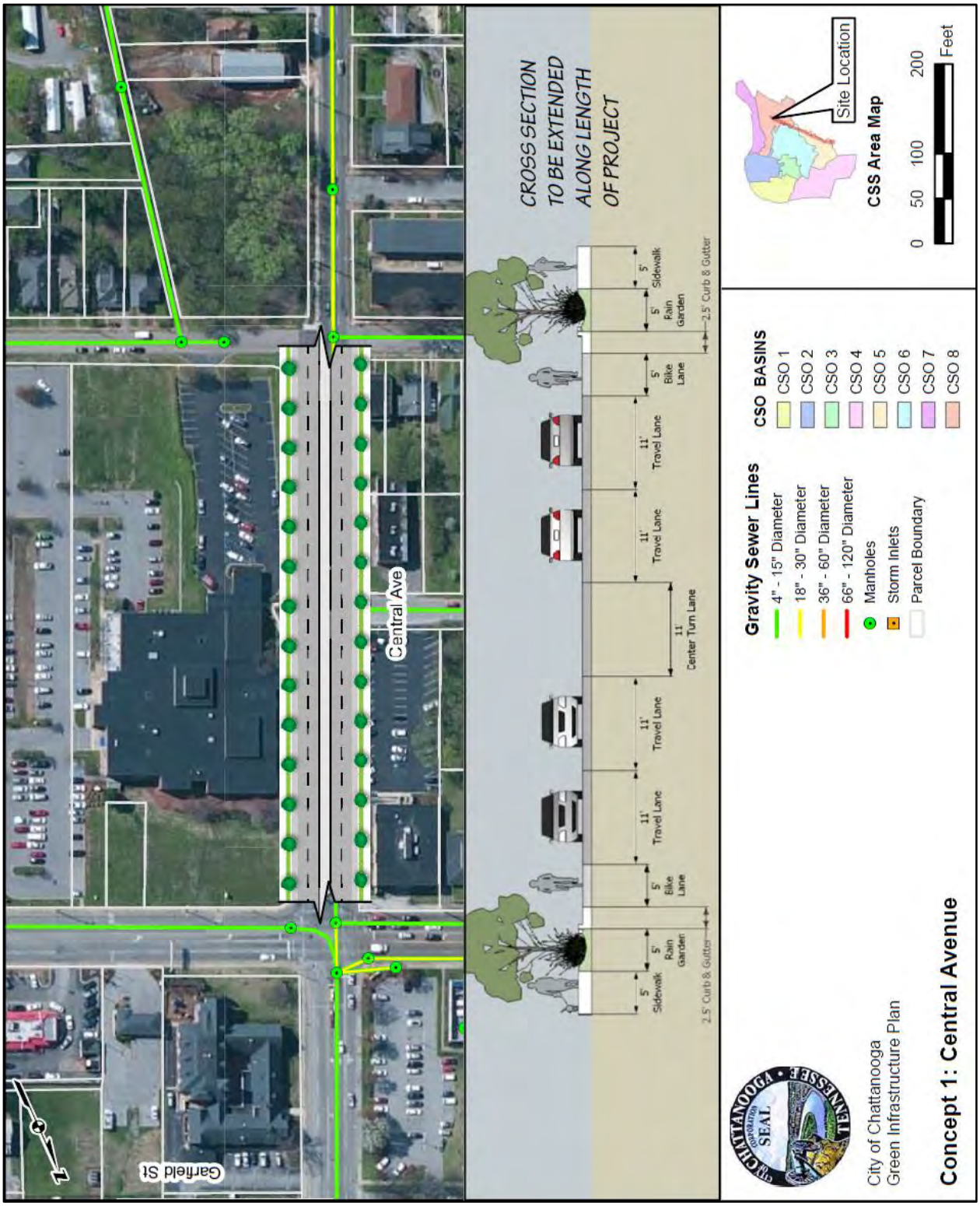
1. SOV provided is approximately 111,360 cubic feet or 830,031 gallons per storm event 2.1" or greater.

Estimate of Probable Green Capital Cost

1. $1,113,600.00 based on infiltration practice only with mid height area equal to 69,600 s.f. and Unit Cost of $16.00 per square foot.
2. Capital Cost Per Unit Volume (Gal) = $1.34

The demonstration concept plan for Central Avenue is shown in Figure H-1.

Figure G-1
Demonstration Concept 1: Central Avenue



Demonstration Concept 2: Patten Parkway

Strategy:

Green Parking, Green Streets

Description:

The Miller Park district is the spatial and psychological center of Chattanooga. Patten Parkway is key location within the Miller Park District. The City is poised to undertake renovations to Patten Parkway as part of the City Center Plan. Patten Parkway is proposed to be revitalized as multipurpose street and square that can be closed off to traffic during special events. The concept demonstrates GI controls that may be implemented as part of the revitalization to capture SOV.

Concept Goals:

1. 2.1" SOV

RMG Tool Input:

1. SOV Design Rainfall equals 2.1".
2. Total Proposed Impervious Area approximately 50,000 s.f. This concept divided into two drainage areas for each side of right of way.
3. Rv = 0.85
4. Required SOV is approximately 7,438 cubic feet
5. The proposed mid-height area for infiltration practices is equal to 7,600 square feet on each side of ROW
6. 0.1" per hour infiltration rate assumed.

RMG Tool Summary

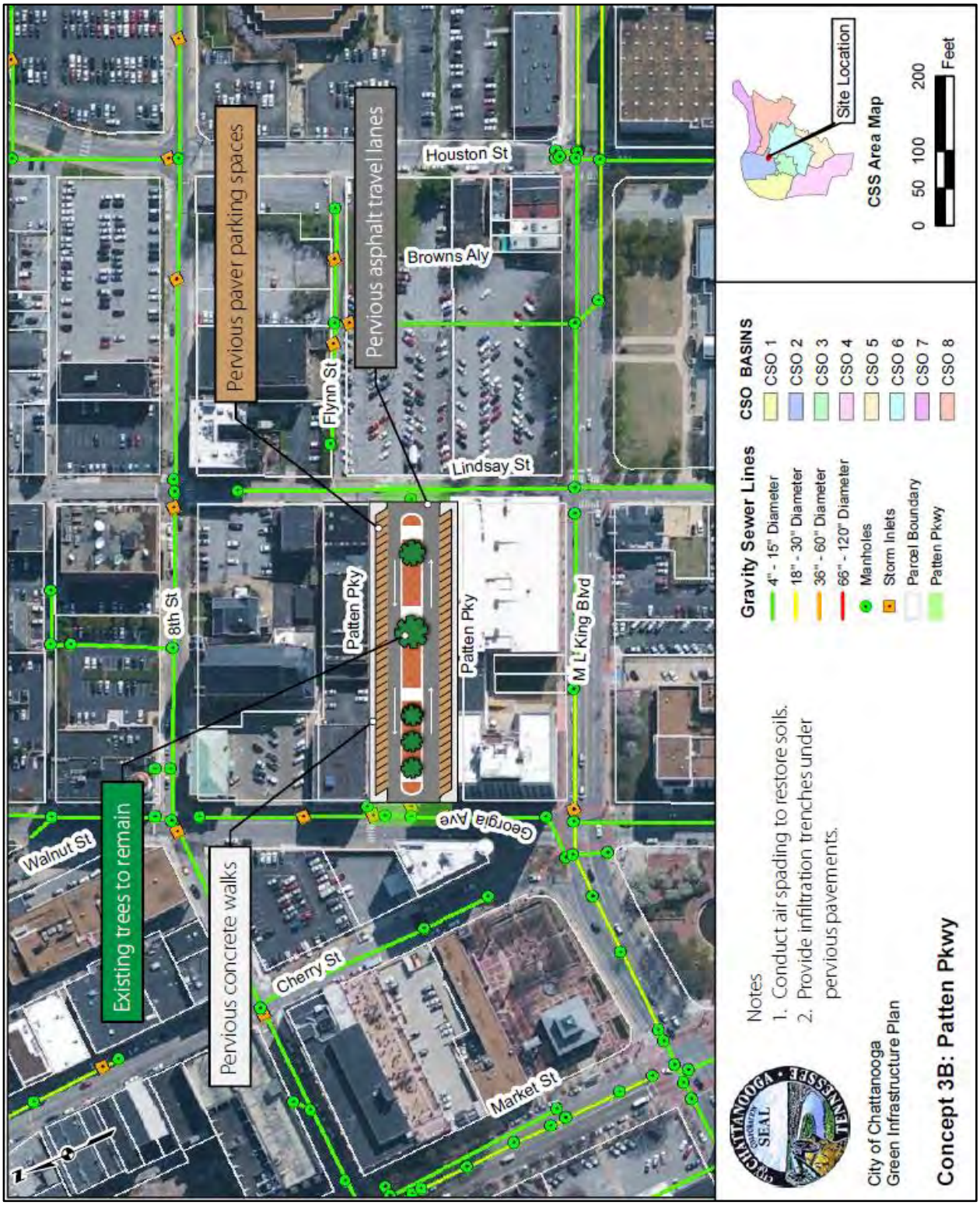
1. SOV provided is approximately 9,120 cubic feet or 68,222 gallons per storm event 2.1" or greater.

Estimate of Probable Green Capital Cost

1. $152,000.00 based on infiltration practice only with mid height area equal to 15,200 s.f. and Unit Cost of $10.00 per square foot.
2. Capital Cost Per Unit Volume (Gal) = $2.22

The concept plan for Patten Parkway is shown in Figure H-2.

Figure G-2
Demonstration Concept 2: Patten Parkway



Demonstration Concept 3: Ross's Landing

Strategy:

Green Open Spaces

Description:

Ross's Landing is a historic landmark with a key social and recreational focus located along the Tennessee River in downtown Chattanooga. The park can be accessed via the well-known Riverwalk. This publicly-owned space is large, open, and amenable to a wide array of GI applications. The City is currently considering master planning for this area along Riverfront Parkway, as well as a possible disconnection from the CSS system. The concept demonstrates GI controls that may be implemented as part of the existing open space to capture SOV.

Concept Goals:

1. 2.1" SOV

RMG Tool Input:

1. SOV Design Rainfall equals 2.1"
2. Total proposed impervious Area is approximately 22,700 s.f.
3. Rv = 0.99.
4. Required SOV is approximately 3,933 cubic feet.
5. The proposed mid-height area for infiltration practices is equal to 3,600 square feet.
6. 0.1" per hour infiltration rate assumed.

RMG Tool Summary

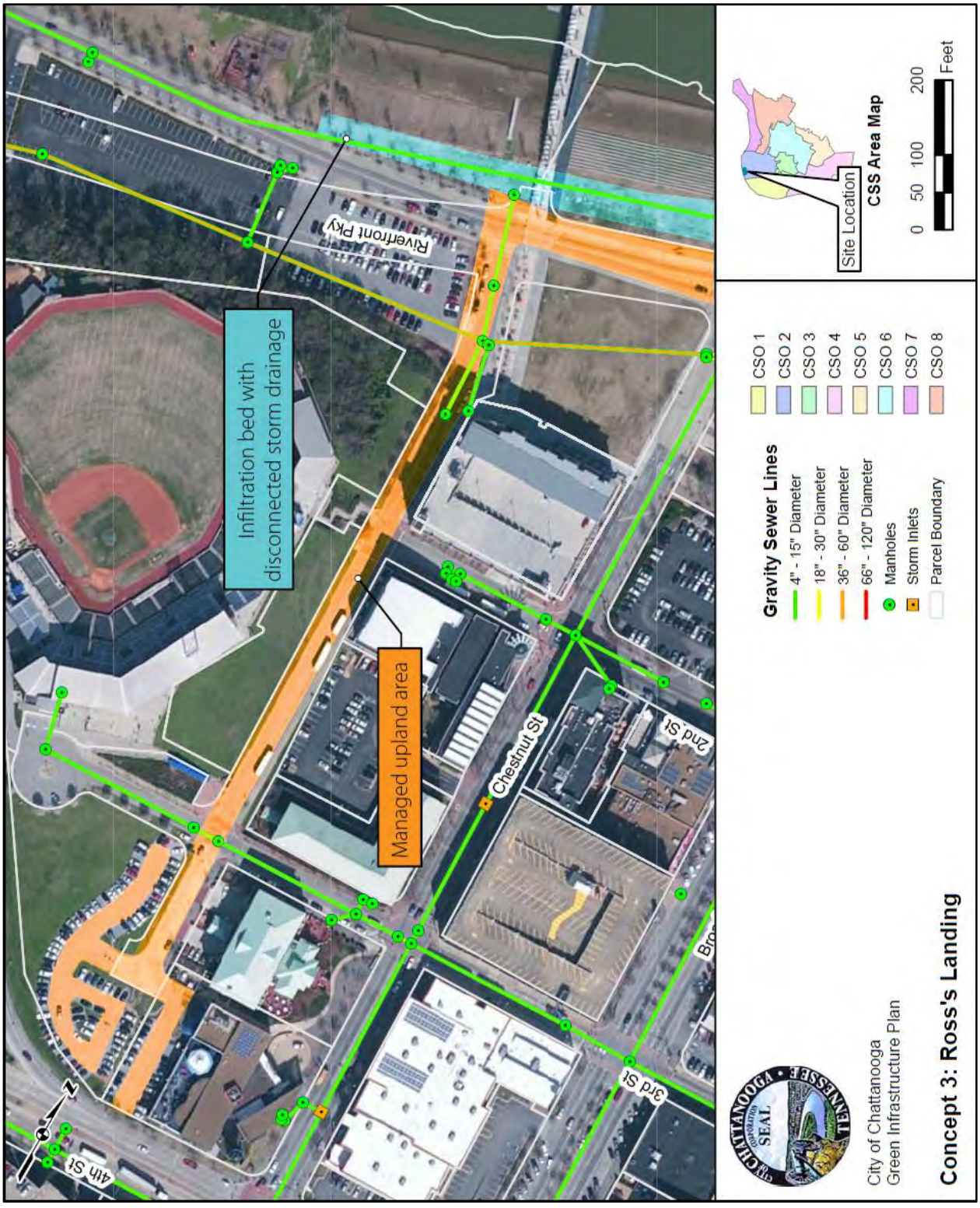
1. SOV provided is approximately 5,760 cubic feet or 43,088 gallons per storm event 2.1" or greater.

Estimate of Probable Green Capital Cost

3. $57,600.00 based on infiltration practice only with mid height area equal to 3,600 s.f. and Unit Cost of $16.00 per square foot.
4. Capital Cost Per Unit Volume (Gal) = $1.33

The concept plan for Ross's Landing is shown in Figure H-3.

Figure G-3
Demonstration Concept 3: Ross's Landing



Demonstration Concept 4: Warner Park

Strategy:

Green Public Facility

Description:

The Chattanooga Zoo is about to embark on $7 million dollar expansion plan that will transform the Zoo into one of the nation's premier zoological parks. This will be a phased growth plan over the next three to five years. The zoo shares an approximately 45.22 acre site with Warner Park. A continuous open space designed to separate these two uses both visually and functionally may be used to improve the existing GI controls and impervious areas located at Warner Park.

Existing naturalized basins, open space, and a standard gray conveyance system in conjunction with a pump station facility, are currently used to manage runoff from this Warner Park and upstream areas. The concept demonstrates GI controls that may be implemented as part of the existing open space and parking to capture SOV and manage run-off to this facility.

Green Open Space Concept Goals:

1. Increase plantings to meet 15% Tree Canopy Goal
2. 1" SOV

Green Open Space RMG Tool Input:

1. SOV Design Rainfall equals 1".
2. Total proposed impervious area is approximately 41,384 s.f. This concepts assumes that existing open spaces is a maximum of 3% impervious.
3. Rv = 0.70
4. Required SOV = 6,190 cubic feet
5. 90 Trees for Restorative credits for Change Cover Type
6. The proposed mid-height area for the aggregated Infiltration practices are equal to 10,611 square feet.
7. 0.1" per hour infiltration rate assumed

Green Open Space RMG Tool Summary:

1. SOV provided is approximately 7,428 cubic feet or 55565 gallons per storm event 1" or greater.

Green Open Space Estimate of Probable Green Capital Cost:

1. $424,440.00 based on infiltration practice only with mid height area equal to 10,611 s.f. and Unit Cost of $40.00 per square foot.
2. Capital Cost Per Unit Volume (Gal) = $7.63

Green Parking Concept Goals:

1. 2.1” SOV

Green Parking RMG Tool Input:

1. SOV Design Rainfall equal to 2.1”
2. Total proposed impervious area is approximately 90,200 s.f., the concept assumes the entire parking lot is impervious.
3. Rv = 0.99
4. Required SOV is approximately 15,627 cubic feet.
5. The proposed mid-height area for aggregated pavement and infiltration practices are equal to 37,544square feet.
6. 0.1” per hour infiltration rate assumed.

Green Parking RMG Tool Summary:

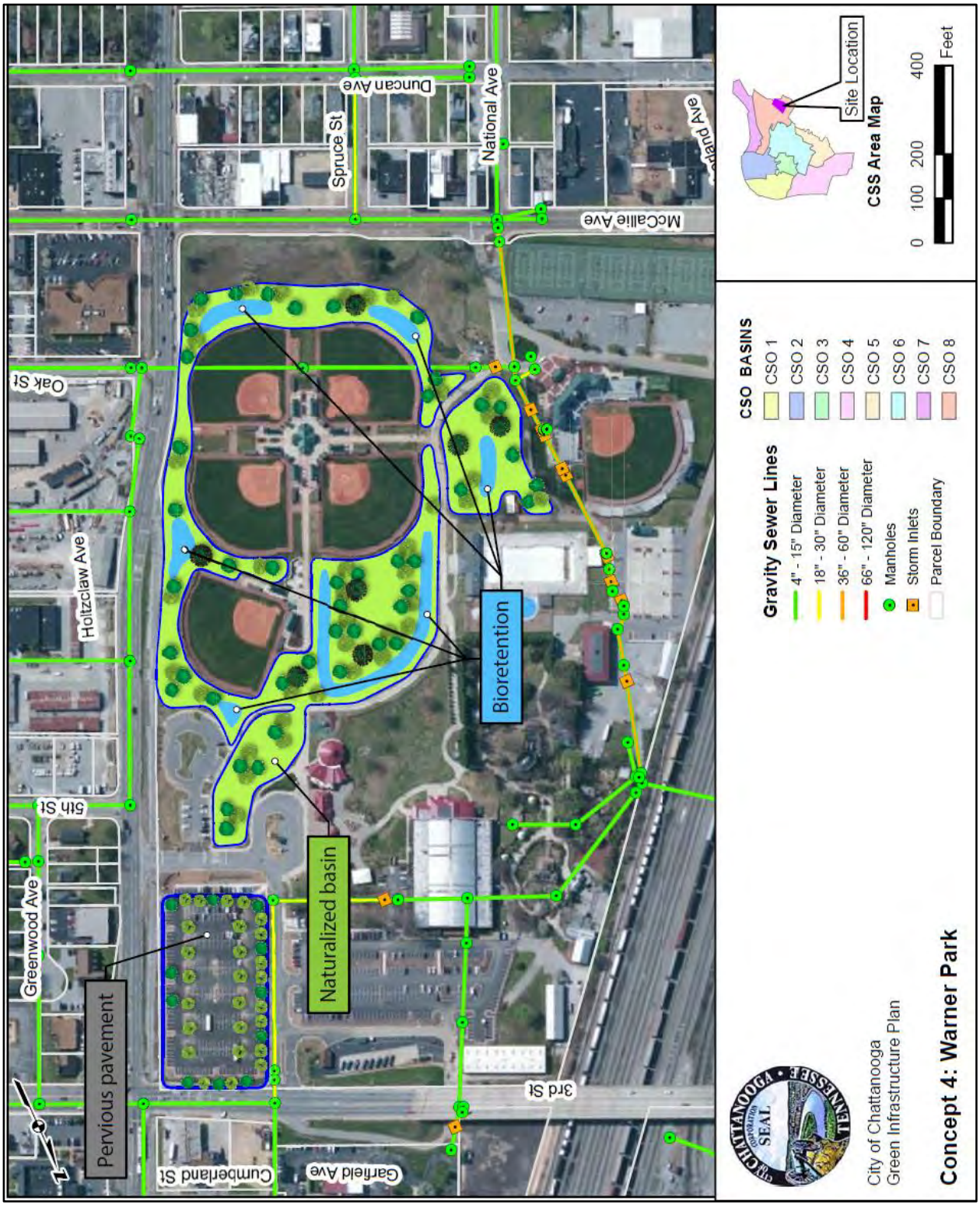
1. SOV provided is approximately 19,659 cubic feet or 147059 gallons per storm event 2.1” or greater.

Green Parking Estimate of Probable Green Capital Cost:

1. $600,704.00 with mid height area equal to 378,544 s.f. and Unit Cost of $16.00 per square foot.
2. Capital Cost Per Unit Volume (Gal) = $4.08

The concept plan for Warner Park shown in Figure H-4.

Figure G-4
Demonstration Concept 4: Warner Park



Demonstration Concept Plan Assumptions

An average 53” annual rainfall in Chattanooga, Tennessee, referenced from the RMG.

A composite runoff coefficient (Rv) for contributing drainage calculated using designations from Table H-1.

Table H-1
Small Storm Hydrology Coefficients (Rv) for Urban Land Uses

Surface Condition	Land Cover	Rv for 0.5”	Rv for 1.0”	Rv for 1.6”	Rv for 2.1”
Impervious	Flat Roof	0.79	0.85	0.88	0.90
Impervious	Pitched Roof	0.95	0.97	0.99	0.99
Impervious	Large Impervious	0.97	0.98	0.99	0.99
Impervious	Small Impervious	0.64	0.70	0.79	0.85
Pervious	Sandy Soils	0.02	0.03	0.05	0.08
Pervious	Typical Urban Soils	0.10	0.12	0.15	0.18
Pervious	Clayey Soils	0.19	0.21	0.24	0.27

GI controls effective at managing runoff volume are listed in Table H-2. Additional GI controls may be applicable for the site but were not considered in volume reduction calculations.

Table H-2
Volume Reduction GI Controls

GI Control	Capture Volume Goal (in)	Loading Ratio
Pervious Pavement	2”	1:10
Infiltration Beds	2”	1:10
Bioretention	1”	1:10
Green Roof	1”	1:1
Rain Barrels/Cistern	1”	Varies
Stormwater Planter	1”	1:5
Naturalized Basin	1”	1:10

Pervious pavements consist of a minimum 8” gravel base with 40% voids. Additional storage may be obtained with the implementation of a subsurface infiltration bed. Refer to the RMG Section 5.3.1 Figure 5.3.1-2 for the assumed pervious pavement cross section.

Infiltration beds consist of a minimum 24” gravel base with 40% voids wrapped in geotextile fabric. The infiltration bed may be used in conjunction with the other GI controls to achieve greater capture volumes. Refer to the RMG Section 5.3.2 Figure 5.3.2-2 for the assumed infiltration bed cross section.

Bioretention areas manage stormwater runoff volume with a 6” surface storage area, a minimum 24” layer of bioretention soil at 20% voids, and a minimum 24” stone bed. Additional storage may be obtained with the implementation of a subsurface infiltration bed. Refer to the RMG Section 5.3.4 Figure 5.3.4-2 for the assumed bioretention cross section.

Green roofs manage the runoff volume at the source effectively removing the area from runoff calculations. To qualify for the exclusion, a 3” media depth with 30% voids is assumed for the concept plan development.

Rain barrels/cisterns are assumed to manage the runoff volume of a 1” rainfall from roofs only. Large commercial systems are capable of harvesting runoff from other sources, but were not considered in the concept plans.

Stormwater planters manage runoff volumes with a 6” surface storage area, a 24” layer of bioretention soil at 20% voids, and a 24” stone bed. Additional storage may be obtained with the implementation of a subsurface infiltration bed. Refer to the RMG Section 5.3.11-8 for the assumed stormwater planter cross section.

Naturalized basins consist of a 1” surface storage area for evapotranspiration and a 12” modified soils and plantings area at 20% voids.

Appendix I

Unit Cost Development Memo

GRESHAM
SMITH AND
PARTNERS

MEMORANDUM

TO: Dempsey Ballou, PE — Gresham, Smith and Partners

FROM: Danielle Dresch, PE — Gresham, Smith and Partners

DATE: November 16, 2014

SUBJECT: GI CONTROL MEASURES UNIT COST TECHNICAL MEMORANDUM
CHATTANOOGA GI MASTER PLAN
CHATTANOOGA, TN
GS&P Project No. 29470.00

The following is an individual cost summary for each identified Green Infrastructure (GI) control. Cost estimates were developed by assuming quantities consistent with typical construction practices and engineering experience. Unit costs were obtained from nationally recognized cost data resources, local contractor bid tabulation results, and information obtained from similar projects performed by GS&P.

Pervious Pavement

The pervious pavement estimate was based on a one-acre retrofit of an existing parking lot with an 18" gravel drainage layer. Other assumptions include:

- Curb length was estimated with an assumption of a square lot (four, 210-ft sides) and the equivalent length of two (2) additional sides to account for internal curbing for a total length of 1252 L.F.
- The striping lump sum is based on $13.25/parking stall with 115 stalls.
- The underdrain quantity was estimated assuming a square lot with 210-ft sides and underdrains spaced 20' apart totaling ten underdrains, each 210 feet long.
- The storm sewer outlet quantity was estimated using an average of 200 feet of 8-inch HDPE pipe.
- The seeding and topsoil quantities were assumed based on a 10-foot wide buffer around the perimeter of a square 1-acre site.

Table 1 shows the estimated quantities converted to a square foot cost for a 1-acres site.

Table 1. Pervious Pavement Cost Estimate Worksheet

Item	Description	Quantity	Unit	Unit Price	Total
1	Demolish & Remove Pavement	672	CY	$ 1	$ 672
2	Demolish & Remove Curb	1252	LF	$ 4	$ 5,009
3	Excavation	2286	CY	$ 18	$ 41,140
4	Disposal	2286	CY	$ 10	$ 22,856
5	Pervious Concrete/Pavers	43560	SF	$ 2	$ 106,722
6	Stone Base	1748	CY	$ 10	$ 17,478
7	Filter Fabric	4840	SY	$ 2	$ 9,680
8	Curb	1252	LF	$ 16	$ 20,036
9	Striping	1	LS	$ 2,000	$ 2,000
10	Underdrain	2205	LF	$ 18	$ 39,690
11	Clean out	10	EA	$ 500	$ 5,000
12	Storm Sewer Outlet	200	LF	$ 50	$ 10,000
13	Seeding	928	SY	$ 1	$ 1,345
14	Topsoil	928	SY	$ 6	$ 5,566
			Subtotal		$ 287,193
			50% Contingency		$ 143,597
			Total		$ 430,790
			Unit Cost: $/SF		**$ 10**

Infiltration Bed

The infiltration bed used for cost estimating purposes is a stand-alone one-acre bed with two feet of stone storage volume and two feet of soil media. The entire site also requires topsoil and seeding. Table 2 depicts the estimated total cost of a one-acre infiltration bed converted to a square foot cost.

Table 2. Infiltration Bed Cost Estimate Worksheet

Item	Description	Quantity	Unit	Unit Price	Total
1	Excavation	6453	CY	$ 18	$ 116,160
2	Disposal	6453	CY	$ 10	$ 64,533
3	Outlet Structure	1	EA	$ 1,500	$ 1,500
4	Storm Sewer Outlet	200	LF	$ 50	$ 10,000
5	Underdrain	210	LF	$ 18	$ 3,780
6	Clean out	1	EA	$ 500	$ 500
7	Filter Fabric	9680	SY	$ 2	$ 19,360
8	Stone Backfill	3227	CY	$ 50	$ 161,333
9	Soil Media	4840	CY	$ 15	$ 72,600
10	Seeding	4840	SY	$ 1	$ 7,018
			Subtotal		$ 456,784
			50% Contingency		$ 228,392
			Total		$ 685,176
			Unit Cost: $/SF		**$ 16**

Bioretention Cell

The cost estimate of a bioretention cell of 100 feet by 10 feet is shown in Table 3. It assumes a two foot deep bioretention soil media, two foot deep stone bed, and six inches of free board and nine inches of surface storage. There is a perforated distribution pipe (underdrain) with clean out and a storm sewer outlet. The bioretention cell cost was converted to square foot cost. Install infiltration bed to achieve additional volume removal.

Table 3. Bioretention Cell Cost Estimate Worksheet

Item	Description	Quantity	Unit	Unit Price	Total
1	Excavation	194	CY	$ 18	$ 3,500
2	Disposal	194	CY	$ 10	$ 1,944
3	Outlet Structure	1	EA	$ 1,500	$ 1,500
4	Storm Sewer Outlet	200	LF	$ 50	$ 10,000
5	Underdrain	5	LF	$ 18	$ 90
6	Clean out	1	EA	$ 500	$ 500
7	Filter Fabric	223	SY	$ 2	$ 446
8	Stone Backfill	74	CY	$ 50	$ 3,704
9	Soil Media	74	CY	$ 15	$ 1,111
10	Plantings	1000	SF	$ 3	$ 3,000
11	Mulch	1000	SF	$ 1	$ 1,000
			Subtotal		$ 26,795
			50% Contingency		$ 13,398
			Total		$ 40,193
			Unit Cost: $/SF		**$ 40**

Vegetated Swale

A vegetated swale that is 300 feet long with 2 foot berms on either side and 1 foot deep with 3:1 side slopes is depicted in Table 4. A vegetated swale requires not only excavation and disposal, but also grading, topsoil, seeding, and a rock check damn. The maximum slope for a swale is 8%. The total cost is converted to square feet.

Table 4. Vegetated Swale cost estimate worksheet

Item	Description	Quantity	Unit	Unit Price	Total
1	Excavation	156	CY	$ 18	$ 2,800
2	Disposal	156	CY	$ 10	$ 1,556
3	Soil Media	89	CY	$ 15	$ 1,333
4	Grading	533	SY	$ 0.25	$ 133
5	Seeding	533	SY	$ 1	$ 773
6	Rock Check Dam	1	EA	$ 500	$ 500
			Subtotal		$ 7,095.55
			50% Contingency		$ 3,547.78
			Total		$ 10,643.33
			Unit Cost: $/SF		**$ 2.22**

Filter Strips

A filter strip of 300 feet by 15 feet is used in this example. It is assumed that no excavation or disposal is required, just finished grading and preparing the site for sod. Please refer to Table 5 and note that it has been converted to a square foot unit cost.

Table 5. Filter Strip cost estimate worksheet

Item	Description	Quantity	Unit	Unit Price	Total
1	Topsoil	500	SY	$ 6	$ 3,000
2	Grading	500	SY	$ 0.25	$ 125.00
3	Seeding	500	SY	$ 1	$ 725.00
			Subtotal		$ 3,850.00
			50% Contingency		$ 1,925.00
			Total		$ 5,775.00
			Unit Cost: $/SF		**$ 1**

Green Roofs

There are many factors that affect the cost of a green roof. For example:

- Weather the green roof is extensive or intensive
- The type of plant species
- The extent of building modifications
- The necessity of wind erosion stabilization systems

For these reasons, the cost of a green roof could vary significantly, and, therefore, a cost for this GI has not been calculated.

Rain Barrel/Cistern

The Rain Barrel/Cistern cost in Table 7 is calculated per gallon and has been determined based on other sources:

- The City of Lancaster, PA Green Infrastructure Plan dated April 2011
- Sustainable Stormwater Management Plan 2008 (New York City)
- Fresh Coast Green Solutions (Milwaukee)
- Onondaga County, New York Save the Rain Program 2010-2018 Green Infrastructure Plan Updated January 2012

Table 7. Rain Barrel cost estimate worksheet

Item	Description	Quantity	Unit	Unit Price	Total
1	Rain Barrel/Cistern	1	Gal	$ 3	3.00
			Subtotal		3.00
			50% Contingency		1.50
			Total		4.50
			Unit Cost: $/gal		**$ 5**

Disconnect Impervious Area

Examples of disconnecting impervious area include, but are not limited to, rooftop disconnection, pavement disconnection, maximizing tree canopies over impervious covers, installing green roofs, and installing porous pavement. Because disconnecting impervious area is a broad topic, this cost can vary and is project dependent.

Stormwater Planters

The typical retro-fit stormwater planter used to calculate cost is three feet wide by 20 feet long with six inches of No. 3 aggregate wrapped in filter fabric. It is installed inside a precast concrete planter box. It has an underdrain, 24 inches of soil media, and plantings. Table 8 calculates a cost in square feet excluding the cost of trees.

Table 8. Stormwater Planters cost estimate worksheet

Item	Description	Quantity	Unit	Unit Price	Total
1	Demolish & Remove Pavement	1	CY	$ 1	$ 1
2	Demolish & Remove Curb	20	LF	$ 4	$ 80
1	Excavation	6	CY	$ 18	$ 103
2	Disposal	6	CY	$ 10	$ 57
3	Stone Base	1	CY	$ 10	$ 11
4	Filter Fabric	7	SY	$ 2	$ 13
5	Curb	20	LF	$ 16	$ 320
6	Underdrain	20	LF	$ 18	$ 360
7	Clean out	1	EA	$ 500	$ 500
8	Precast Concrete Planter	1	EA	$ 2,500	$ 2,500
7	Plantings	60	SF	$ 3	$ 180
8	Soil Media	4	CY	$ 15	$ 67
			Subtotal		$ 4,193
			50% Contingency		$ 2,096
			Total		$ 6,289
			Unit Cost: $/SF		**$ 105**

Manufactured Devices

Manufactured devices is another GI control that is project dependent and, therefore, has a cost that varies.

Naturalized Basins and Retrofitting Existing Basins

Table 9 shows the cost of a naturalized basin that is an acre in size, has a 3 foot deep wet weather storage capacity and a 1.5 foot deep permanent pool. The final value is in square feet.

Table 9. Naturalized Basin cost estimate worksheet

Item	Description	Quantity	Unit	Unit Price	Total
1	Excavation	7260	CY	$ 18	$ 130,680
2	Disposal	7260	CY	$ 10	$ 72,600
3	Outlet Structure	1	EA	$ 1,500	$ 1,500
4	Storm Sewer Outlet	200	LF	$ 50	$ 10,000
5	Seeding	456	SY	$ 1	$ 662
6	Plantings	4108	SF	$ 3	$ 12,324
7	Topsoil	152	CY	$ 6	$ 913
			Subtotal		$ 228,679
			50% Contingency		$ 114,339
			Total		$ 343,018
			Unit Cost: $/SF		**8**

The cost to retrofit an existing basin was developed assuming a one acre basin. The soil amendment is six inches deep and covers extents of the existing basin. It is assumed that 50% of the site would require grading and there is a 50/50 mix of plantings and seedings. A retrofit may also require replacing or installing a storm sewer outlet. Please see Table 9 for the unit cost in square feet.

Table 10. Retrofitting Existing Basin cost estimate worksheet

Item	Description	Quantity	Unit	Unit Price	Total
1	Soil Amendment	807	CY	$ 0.33	$ 266
2	Grading	2418	SY	$ 0.25	$ 604
3	Plantings	4108	SF	$ 3	$ 12,324
4	Seeding	456	SY	$ 1.45	$ 661
5	Outlet Structure	1	EA	$ 1,500	$ 1,500
6	Storm Sewer Outlet	200	LF	$ 50	$ 10,000
			Subtotal		$ 25,356
			50% Contingency		$ 12,678
			Total		$ 38,034
			Unit Cost: $/SF		**$ 1**

Summary Table

Table 11 is a summary of all the GI practices.

Table 11. Summary Table

Item	Unit	Capital Cost per Unit	Capital Cost per Gallon	Capital Cost per Cubic Foot
Pervious Pavement	SF	$ 10	$ 3.31	$ 24.72
Infiltration Bed	SF	$ 16	$ 2.63	$ 19.66
Bioretention Cell	SF	$ 40	$ 3.16	$ 23.64
Vegetated Swale	SF	$ 2	$ 3.39	$ 25.34
Vegetated Filter Strip	SF	$ 1	$ 8.17	$ 61.11
Green Roof	SF	Varies	Varies	Varies
Rain Barrel/Cistern	GAL	$ 5	$ 4.50	$ 33.66
Disconnect Impervious Area	SF	Varies	Varies	Varies
Stormwater Planters	SF	$ 105	$ 8.24	$ 61.66
Manufactured Devices	EACH	Varies	Varies	Varies
Retrofitting Existing Basin	SF	$ 1	$ 0.41	$ 3.08
Naturalized Basin	SF	$ 8	$ 3.72	$ 27.79

Appendix J

Project Rating System Tool

Table I-1
Project Rating System (1 of 4)

Project ID	Project Name	Address	Strategies	Data Input: Project Cost	Data Input: Stormwater Detained and Captured (gal)	Calculation: Project Cost / Stormwater Detained and Captured ($/gal)	Score: Project Cost / Stormwater Detained and Captured ($/gal)	Data Input: Partnership Opportunity?	Score: Partnership Opportunity	Data Input: Available Space?	Score: Available Space
1	Central Avenue	-	Green Streets	$ 1,113,600	830,031	$1.34	2	Supportive with financial resources	2	City-owned, limited acquisition necessary	1
2	Patten Parkway	928 Market St.	Green Parking, Green Sreets	$ 152,000	68,222	$2.23	2	Supportive with financial resources	2	City-owned, no acquisition necessary	2
3	Ross's Landing	101 Riverfront Pkwy	Green Open Space	$ 57,600	43,088	$1.34	2	Supportive with financial resources	2	City-owned, no acquisition necessary	2
4	Warner Park	301 N. Holtzclaw Ave.	Green Facility	$ 1,025,144	202,624	$5.06	0	Supportive with financial resources	2	City-owned, no acquisition necessary	2

Table I-2
Project Rating System (2 of 4)

Project ID	Project Name	Address	Strategies	Data Input: Operation and Maintenance?	Score: Operation and Maintenance	Data Input: Reliability?	Score: Reliability	Data Input: Feasibility?	Score: Feasibility	Data Input: CSS Basin?	Score: CSS Basin
1	Central Avenue	-	Green Streets	Low	2	Storage / Infiltration	1	Medium	1	Sewershed 5	2
2	Patten Parkway	928 Market St.	Green Parking, Green Sreets	Low	2	Storage / Infiltration	1	High	2	Sewershed 2	0
3	Ross's Landing	101 Riverfront Pkwy	Green Open Space	Low	2	Remove from CSS	2	Medium	1	Sewershed 2	0
4	Warner Park	301 N. Holtzclaw Ave.	Green Facility	Medium	1	Storage / Infiltration	1	High	2	Sewershed 8	2

Table I-3
Project Rating System (3 of 4)

Project ID	Project Name	Address	Strategies	Data Input: Total Site Area	Data Input: Site Impervious Area	Calculation: Total Site Impervious Area	Score: Total Site Impervious Area	Data Input: Environmental Cleanup Sites?	Score: Environmental Cleanup Sites	Data Input: Initial Tree Canopy Area	Data Input: Proposed Tree Canopy Area
1	Central Avenue	-	Green Streets	14.60	13.12	89.86%	2	None	0	0.73	2.19
2	Patten Parkway	928 Market St.	Green Parking, Green Sreets	1.15	1.09	94.78%	2	None	0	0.06	0.06
3	Ross's Landing	101 Riverfront Pkwy	Green Open Space	0.52	0.49	94.23%	2	None	0	0.03	0.03
4	Warner Park	301 N. Holtzclaw Ave.	Green Facility	3.02	2.00	66.23%	1	None	0	0.15	0.45

Table I-4
Project Rating System (4 of 4)

Project ID	Project Name	Address	Strategies	Calculation: Initial Tree Canopy Percent Cover	Calculation: Proposed Tree Canopy Percent Cover	Score: Increased Tree Canopy	Data Input: Integration with planning documents?	Score: Integration with planning documents?	Data Input: Vacant and Unused Land Revitalization	Score: Vacant and Unused Land Revitalization	Score
1	Central Avenue	-	Green Streets	5%	15%	2	Project Specified in Planning Document	2	Not Unused and Undeveloped Land	0	**150**
2	Patten Parkway	928 Market St.	Green Parking, Green Sreets	5%	5%	0	Project Specified in Planning Document	2	Not Unused and Undeveloped Land	0	**135**
3	Ross's Landing	101 Riverfront Pkwy	Green Open Space	5%	5%	0	No	0	Not Unused and Undeveloped Land	0	**115**
4	Warner Park	301 N. Holtzclaw Ave.	Green Facility	5%	15%	1	No	0	Not Unused and Undeveloped Land	0	**100**

Appendix K

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