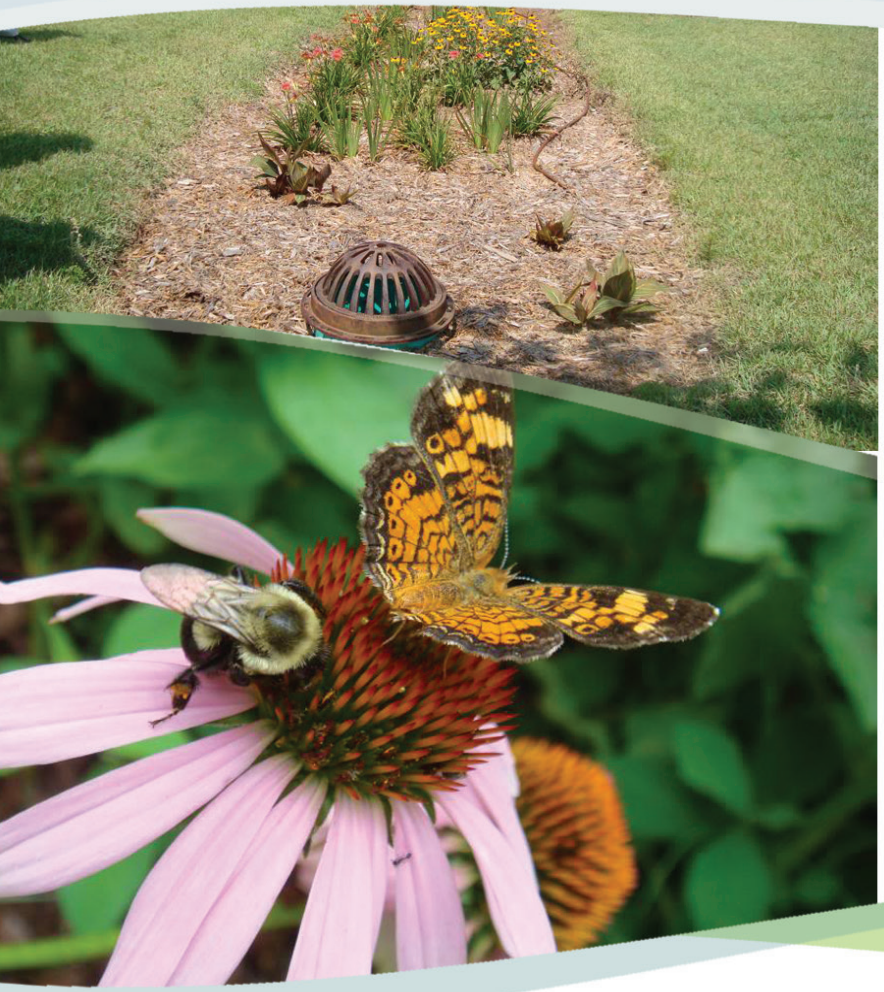
Guidance Document for the Integration of Green Infrastructure

City of Auburn, AL



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Background

Introduction

The City of Auburn seeks to grow and attract residents, businesses, and visitors while concurrently reducing the impact growth has on the natural environment and the City's ability to maintain its infrastructure, property, and quality of life. The City is invested in using natural processes, vegetation, and soils to manage water and create healthier urban environments through the use of green infrastructure. The City of Auburn's: Guidance Document for the Integration of Green Infrastructure supports the City's vision by being a comprehensive review of documents and recommendations for reducing the environmental impact of existing infrastructure and future development.

Prior to development of this document, the City of Auburn had already included elements related to GI in other planning documents. For example, the City of Auburn's Comprehensive Plan is centered on "good growth". The Parks, Recreation, and Culture Master Plan's purpose includes a commitment to quality parks, greenspace/greenways, and natural features. The City and surrounding communities and organizations have worked extensively on developing watershed management plans and water quality data with the common purpose of sustaining natural resources for future generations.

The City recognizes that the presence of impaired local streams is in contradiction to its stated vision and commitment to be an attractive, environmentally conscious community that is progressive, responsive and hospitable. The City understands these impaired local streams and associated added regulatory burdens also represent an expenditure of resources for the City, the development community, and ultimately, the citizens of Auburn.

Figure 1: Pervious pavers are showcased at the entrance to Auburn University.

The City of Auburn identified the need to analyze stormwater management from both stormwater quality and stormwater quantity perspectives in order to move their stormwater management program forward. The City also recognized that each proposed policy or ordinance change needed to be carefully considered from several angles since changes can affect multiple City departments, multiple stakeholders, and the longevity and maintenance of City and private property.

Summary of Project Background

This City of Auburn: Guidance Document for the Integration of Green Infrastructure (GI) develops a framework to implement GI and sustainable stormwater design program practices into local stormwater management using the following four pillars as a framework:

1. Policy and standards review and recommendations,
2. Design standards, guidance and specifications,
3. Pilot project planning (identify opportunities) and concept level design, and
4. Education of and assistance to the development community.

Provided below is an abbreviated summary of the process and meetings held to develop this Guidance Document for the Integration of Green Infrastructure.

- Wood Environment & Infrastructure Solutions, Inc. ("Wood") held a project kickoff meeting with key staff from multiple City departments on October 24, 2017. The meeting discussed short-term and long-term project goals; critical opportunities and issues; internal and external stakeholders; available studies; reports and data; Guidance Document uses and expectations; and project schedule.
- Wood provided a questionnaire on policies and processes for private land development and City staff provided input by email the week of February 5, 2018. Wood then facilitated conference calls to discuss the results.
- Stakeholders and target audiences (e.g., engineers, surveyors, landscape architects, architects, developers, builders, etc.) were identified to discuss concerns and opportunities as they relate to stormwater management and GI and to provide feedback.
- Documents and data related to stormwater management, GI, and pilot project development for both public and private projects were reviewed and discussed with stakeholders. This material included ordinances, manuals, submittal forms, watershed plans, city planning documents, educational presentations and materials, standard details, and documented drainage problems and solutions. Impediments and opportunities related to implementing Green Infrastructure (GI) and sustainable stormwater design were identified.
- A framework for the short-term and long-term implementation of GI for public and private development was developed. General recommendations for changes to local regulatory and guidance documents including general recommendations for incentives, performance standards, and when/where green infrastructure is encouraged versus required was developed.
- Concept Plans for ten GI project sites and associated GI practices were developed and include:
  - Narratives of the proposed green infrastructure (GI) practices including general location and size, and recommendations for long-term operations and maintenance;
  - Project location maps and plan-views including location and connectivity;
  - 3D "photo renderings" of the proposed GI practices in-place;
  - Preliminary engineering calculations for sizing the GI practices and the resultant performance objectives; and
  - Concept-level opinions of construction cost and estimate of long-term maintenance costs.

Current Regulatory Framework

With aging infrastructure, increased flooding and the onset of stormwater quality regulations for municipal separate storm sewer systems (MS4s), local governments across the United States are recognizing the need for stormwater management regulations and policies for both private and public land developments. Many local governments look for the easiest route to enact such regulations, such as adding stormwater quality provisions from the text of the relevant Municipal Separate Storm Sewer System (MS4) permit, to their existing and lax drainage requirements. The stormwater quality language from the permit invariably lacks adequate context or guidance to allow easy interpretation or application of the new requirements. While

Figure 2: Bioretention areas have been installed in Auburn and have been found to improve aesthetics for streetscapes while managing stormwater. Maintenance concerns and incentives for private projects were the focus of discussions on GI/LID during the kick-off meeting and through staff questionnaires.

stormwater quality regulations are now considered a necessity for many communities, ensuring that the regulations are effective and fit well within the community's existing land development permitting process is often overlooked.

Local governments that quickly piecemeal their stormwater management programs together without taking the time to consider the impacts of, and potential opportunities that can grow from, such regulations often end up with a land development process that exacerbates existing stormwater problems (such as flooding and undersized infrastructure), drives up future infrastructure maintenance costs, and increases the frustration of municipal staff, land development stakeholders, and property owners. In addition, attempts to minimize the impacts of the new regulations often miss opportunities to educate the community on GI, solve local water quality and flooding problems, keep pace with sustainability efforts, and reap other benefits inherent in the regulations. An insufficient stormwater program may allow status quo development to continue, but it ultimately does little to reduce eventual cost and allows resources to be wasted on ineffective approaches.

A cohesive and effective municipal stormwater management program for land development is also a comprehensive program that addresses and integrates both stormwater quality and quantity management and considers the impact of ordinance changes or additions to the current land development and BMP (Best Management Practice) maintenance processes. Decisions made about potential changes to the stormwater program should be based on local stormwater program drivers (regulatory, cultural, economic, flood protection, etc.) for the particular community affected. Furthermore, the life-cycle of the land development process should be considered for every aspect of the eventual post-construction regulations and overall program.

The City of Auburn is a community that is facing many of the issues that spur the need for stormwater quality regulation: active public and private redevelopment initiatives; a growing interest in the economic and aesthetic co-benefits of Green Infrastructure/Low Impact Development (GI/LID) land development approaches that are increasingly perceived as community enhancements that spur economic growth; local drainage and flooding issues; and gradually the step-wise transition to more robust stormwater and stream water quality regulations. In examining how other cities have responded to the same issues, the City of Auburn staff recognized both the need for thoughtful consideration when implementing stormwater quality standards, and the potential opportunities for program flexibility and acceptance that can be realized through a stakeholder-based program development process. As a result, the City of Auburn requested that Wood facilitate the initial development and review of stormwater quality regulations and associated program processes and tools. Wood is an international engineering and program management consulting firm with extensive expertise and experience in local government stormwater management in the United States.

The City of Auburn wishes to reduce the impact of expected development on local water resources while improving neighborhood character and attaining realistic construction and maintenance costs. Programmatic and regulatory changes driven by the advent of the National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) program have advanced the thinking about how stormwater is managed on development sites. The result has been a transition from the singular use of detention/retention ponds and other large practices to detain and slowly release runoff to the inclusion of many smaller stormwater management practices to better mimic pre-development hydrology, promote infiltration, and reduce runoff throughout the development site. This change has necessitated a review of how local development regulations can influence and sometimes impede the use of such distributed runoff reduction practices. Nationally, there is also an increase in the use of numeric water quality standards through development of total maximum daily loads (TMDLs) for numerous streams and rivers. These standards, among other things, enhance the need for MS4s to install GI/LID stormwater management practices on developed sites as retrofits. Stormwater ordinance language and design and construction manuals that impede the use of runoff reduction practices on new/redevelopment sites can make compliance in retrofit situations more difficult.

Overview of GI/LID

GI/LID is a planning and engineering design approach that emphasizes conservation and use of on-site natural features for stormwater management and water quality protection. The City of Auburn typically uses the term "green stormwater infrastructure and shortens it to "green infrastructure". The City of Auburn also recognizes GI

as an interconnected network of parks, open spaces, trails, forests, buffers, etc. For the purposes of this document, "LID" is used to describe the planning and development approach, and "GI" is used to describe elements used to manage urban stormwater utilizing natural materials and processes. Both of these and their abbreviations are used in this document. The United States Environmental Protection Agency (USEPA) defines GI as the following (www.epa.gov/green-infrastructure):

> *"Green Infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water."*

Traditionally, stormwater runoff generated from impervious surfaces has been addressed using hard infrastructure (also called "gray infrastructure") to move stormwater quickly off sites and out of roadways, typically through curb and gutter systems, catch basins, pipes and outfalls with little to no water quality treatment. Initial efforts to treat stormwater quality mimicked the end of pipe concepts of detention and retention systems. These systems are being augmented or replaced by smaller, more natural controls nearer the source of the runoff. Thus, municipalities have turned their focus, in part, toward green infrastructure. Some typical GI/LID approaches include the following: downspout disconnection, rainwater harvesting, rain gardens, planter boxes, bioswales, permeable pavements, green alleys and streets, green parking, green roofs, soil modification, urban tree canopy establishment or preservation, and land conservation.

Figure 3: Bioretention areas in Birmingham's Railroad Park.

Summary of Document Review

Wood facilitated a kick-off meeting on October 24, 2017 to discuss the goals and objectives for the Guidance Document development. Attendees and their departments/organizations are summarized in **Table 1**. Topics included policy review and recommendation procedures, pilot project identification and conceptual designs planning, previous GI project in the City of Auburn, and identification of internal and external stakeholders. The City's Internal Technical Review Committee for this Guidance Document is provided in **Table 2**.

At the stakeholder meeting, documents and data provided by the City of Auburn relating to stormwater management, GI, and pilot project development for both public and private projects were reviewed and discussed. This material is summarized in **Table 3** and included ordinances, manuals, submittal forms, watershed plans, city planning documents, educational presentations and materials, standard details, and documented drainage problems and solutions.

The development process in the City of Auburn is shaped by a mix of local regulations and policies administered by several departments. State and federal agencies also exercise some authority over local development process through regulation of waterways, wetlands, State and US roadways, and stormwater management under the MS4 Phase II program. Because this is the case, the local requirements may need to reference these State or federal standards and changes that can be made on the local level need to be identified. Because of the City of Auburn's geography, watershed plans that include portions of the City of Auburn overlap with other municipal and county jurisdictions. This means cooperation and shared information will better facilitate the implementation of shared watershed goals.

Figure 4: Use of permeable pavers at Auburn University.

Table 1: Kick-off Meeting (October 24, 2017) Attendees and their Departments/Organizations

Attendee	Department/Organization
Dan Ballard	Water Resource Management Department
Alison Frazier	Engineering Service Department
Dusty Kimbrow	Water Resource Management Department
Ron McCurry	Water Resource Management Department
Barry Fagan	Volkert, Inc.
Byron Hinchey	Wood
Thom Weintraut	Planning
Heather Williams	Wood
James Jennings	Public Works-Urban Forester
Mike Edwards	City Manager's Office
Christopher Graff	Public Works-GIS Manager
Andy Reese	Wood
Erika Sprouse	Finance Department
Becky Richardson	Parks and Recreation

Table 2: City Technical Review Committee

Attendee	Department
Dan Ballard	Public Works
Marla Smith	Water Resource Management Department
Alison Frazier	Engineering Service Department
Dusty Kimbrow	Water Resource Management Department
Ron McCurry	Water Resource Management Department
Thom Weintraut	Planning
Ann Randall	Public Works-Urban Forester
Scott Cummings	City Manager's Office
Christopher Graff	Public Works-GIS Manager
Erika Sprouse	Finance Department
Becky Richardson	Parks and Recreation

Table 3: Reviewed Documents and their Summaries and Owning Departments

Reviewed Document	Description	Owning Department	Overlapping/Potential Stormwater Inclusion/Goals
Ordinances/Requirements			
Weeds and Other Obnoxious Conditions	Premises and exterior property shall be maintained free from weeds or plant growth in excess of 12 inches. Noxious weeds shall be prohibited. Weeds shall be defined as all grasses, annual plants and vegetation other than trees or shrubs, provided; however, this term shall not include cultivated flowers and gardens.	Codes Enforcement	Promotes maintenance of greenspace. Ongoing Code Enforcement Staff education on rain gardens and native plantings should be considered as a common goal.
Zoning Ordinance	Establishment of districts, regulations of the height, number of stories and size of buildings and other structures, the percentage of lot that may be occupied, the size of yards and other open spaces, the density of population and the use of buildings, structures, and land; and to provide methods of administration of this Ordinance and penalties violation.	Planning/Development Services	Promotes redevelopment and access to existing utilities as a purpose. Defines Conservation Overlay District to protect drinking water. Defines and provides requirements for protection and mitigation of stream buffers. Defines tree and landscape requirements for sites.
Drainage and Flood Control	Construction and alteration of storm drainage and flood control facilities; detention pond design and annual inspections; requirements for building floor elevations; control of natural floodplains, stream channels, and buffers; and BMPs for industrial, commercial, and high risk facilities.	Public Works	New requirements for overbank flood protection and extreme flood protection may overlap with this regulation. Includes requirements for sediment and erosion control and construction site phasing. Includes illicit discharge language and City authority to inspect.
Planning and Development	Staff support for the Planning Commission.	Planning	Not applicable.
Municipal Tree Ordinance	Requires city official review for removal/alteration of trees on public property or ROW and for trees affected by construction permits. Requires replacement of damaged/removed trees on public property or ROW. Establishes tree commission.	Parks and Recreation	Requirements for municipal trees overlaps with goal of Urban Forester review of project.
Streets and Sidewalks	Requirement to follow standards/specs in City Construction Manual, keep dirt off of streets, acquire development permit for street work, mark right-of-ways (ROWs). Street paving surface must be bituminous concrete wearing surface consisting of two hundred (200) pounds per square yard of plant-mix type 416 laid on a primed six-inch compacted crushed stone base. Required pavement widths and curb dimensions.	Public Works	Street width, materials, review and cut information is located here and may need to be updated for GI to allow utility cuts and facilitate curb cuts. Prohibition of sediment on roadways in line with stormwater sediment and erosion control requirements.
Subdivision Regulations	Requirements for lot layout, preliminary plat, land survey, final plat, street layout, lot size and shape, 100-year flood boundary, tree preservation, and natural features and their preservation must be included on plans submitted for review. Where subdivisions include portions of bikeways or greenways, they must be included in a planned right-of-way or easement. This ordinance requires the erosion control plan. Describes local development approval process. Planning Commission approves subdivision development, Planning Director has administrative discretion to approve/authorize some subdivision developments as consistent with the Zoning Ordinance. City Council has authority to authorize/approve subdivision development denied approval by the Planning Commission.	Planning	Purpose includes protection of drinking water, natural resources and drainage and promote open space. Plan review requirements are housed here and will need to be updated to reflect any new stormwater or sediment and erosion control requirements.
Conservation Subdivision Regulations	Conservation subdivision requirements are optional for all subdivisions proposed in the Lake Ogletree Subwatershed that are 10 acres or more and have more than 4 lots. They are required for all areas within the Conservation Overlay District. Must be 50% open space to be owned and maintained by an HOA (homeowner's association). Within the Lake Ogletree Subwatershed, each development site overall impervious surface ratio (ISR) should not exceed 10% of gross area. Stormwater BMPs required for water quality control if the total ISR is projected to exceed 10 percent. For development sites with an ISR above 10 percent, stormwater treatment BMPs shall be designed and installed in a manner to achieve the targeted pollutant removal efficiencies found in the Auburn Water Resource Management Design and Construction Manual.	Planning	Includes many LID elements such as clustering development, greenways, and natural resource preservation. Review requires submittal of a Site Analysis Map prior to submittal of a Concept Plan which could be a model for an optional/incentivized Pre-Planning Meeting/Report for all development projects.
2011 Standard Details for Storm Sewers	3 plan sheets showing standard details for manholes, inlets, headwalls, junction boxes, pipes, curb and gutter, etc.	Engineering	Could be updated to include GI once standards are developed.
2016 Standard Details for Streets	5 plans sheets showing standard street details for curb and gutter, swales, landscape corridors, utility corridors; parking plans for parallel parking, angled parking 90-degree parking, and accessible parking; jack and bore details, mountable island nose, bus turnout, utility street patching; and details for silva cells and tree wells/ grates.	Engineering	Could be updated to include GI/LID once standards are developed.

Reviewed Document	Description	Owning Department	Overlapping/Potential Stormwater Inclusion/Goals
2015 Erosion Control Details	2 plan sheets showing standard details for silt fence, erosion control blanket, inlet filters and sediment basins.	Water Resource Management	Could be updated to include additional BMPs to include better sediment and erosion control, stricter requirements and/or new technologies.
2016 Standard Construction Specifications	Proposal and materials requirement for City projects. Includes requirements/specifications for installation and testing of storm conveyances, embankment, backfill, streets, concrete, water lines, sewer lines, etc.	Public Works	Legal requirements for review of work may be applicable to GI practices. Specifications for GI practices, such as post-construction BMPs, materials, media, plantings, fill, etc.
Post-Development Water Quality Plan Stormwater Application	3-page form for developers to submit including project information and the required design events for each watershed.	Watershed Division	This is a good starting process for looking at project by watershed and can be updated to include the new post-construction regulations.
Stream Buffer Encroachment Application	2-page form for developers to submit including project information, justification, and mitigation for encroaching into a stream buffer.	Water Resource Management	This is a good starting process for identifying and looking critically at stream buffers. It can be updated to include new regulations as they relate to buffers.
Subdivision Plan Review Checklist	Requirements for engineering construction plans for subdivision improvements. Requirements, including submittal for grading and drainage plans and construction site sediment and erosion control are listed.	Public Works	This is a good starting process for submittal requirements. It can be adapted to a new process that incorporates more GI/LID and can be adapted to a Pre-Planning Meeting Report process.
Erosion and Sediment Control Inspection and Enforcement Process Chart	Flow chart showing process of plan submittal and approval process, including: pre-construction meeting, E&SC permitting/inspection, grading and utility permitting, corrective actions, and penalties for non-compliance.	Development Review Team (DRT)	This establishes compliance requirements and correction process. Incorporation of sites into GI database, GIS layers, and maintenance and can be added.
Documents and Studies			
2016 Stormwater Management Program Plan	The status of the stormwater program and the City of Auburn's plan for implementation of the 6 minimum control measures to meet and exceed state requirements. Programs to educate and involve the public, identify and reduce illicit discharges, monitor stormwater, quality, review construction site plans for sediment and erosion control and post-construction measures, and train employees and manage City-owned facilities are summarized.	Watershed Division	Identifies water quality, minimization of erosion and flooding control as goals. The program targets nutrients, sediment, pathogens and other pollutants. All applicable City regulations are summarized in this document annually to show the City of Auburn's efforts to meet State requirements.
DRAFT Parks, Recreation and Cultural Master Plan	Includes a park inventory and needs analysis of the parks, recreation and cultural amenities. Summary of desired updates and projects to improve the quality of the parks, recreation, arts and cultural programming, library, greenspace/greenways, trails, facilities, landscape and natural features. Concept plans for twenty master plan projects are included (included below in Pilot Project Background section).	Parks and Recreation	Identifies demographics and specific locations and amenities the community has a need for (parks, greenspace, trails, etc.).
City of Auburn Stormwater Management Manual	Stormwater design information for local agencies, engineers, developers, etc. This is a guide for City staff, consultants, and citizens to achieve consistency in the design and compliance of stormwater projects so that both growth and environmental guidelines can be followed effectively. Manual outlines runoff estimation, hydraulic design of stormwater conveyance and storage systems, and environmental considerations/requirements for plan review.	Public Works	Defines the requirements for water quality and water quantity control. Will need to be updated to include new regulations for retention and Total Suspended Solids (TSS) removal requirements, overbank flood protection, and extreme flood protection.
CompPlan 2030	Policy guide for future community improvements and decision making and the basic framework for land use, transportation, natural systems, other public services, and community improvements. Water quality concerns, desired restoration and environmental policy changes are included. The plan also summarizes stormwater infrastructure, open space, tree planting/preservation and water quality goals.	Planning	Overlap in goals to protect natural resources, promote urban forests, protect/promote open space, address water quality concerns (sediment, nutrients, and pathogens), promote Site Development Review Tool/Water Resource Manual Design and Construction Manual, promote LID and associated education. CompPlan should continue to be kept up to date with changing stormwater regulations and City requirements through inter-departmental cooperation.
Public Works Design and Construction Manual	Requirements for designing and constructing streets, alleys, sidewalks, bicycle facilities, drainage facilities, erosion and sediment control and traffic management facilities. Establishes that the Development Committee is tasked with evaluating how a proposed project will impact existing public infrastructure or necessitate additional public investment in infrastructure to accommodate a project. Defines the development review process and includes flow chart and list of permits. Includes the requirements for peak flow attenuation. Also includes roadway design, traffic study, greenway design, storm sewer, and other requirements.	Public Works	Water Resource Management is included on the Development Review Team (DRT). A Pre-Construction Meeting is required. Protections for open space and floodplains are included. Stormwater conveyance requirements could be updated to include GI/LID once standards are developed.

Reviewed Document	Description	Owning Department	Overlapping/Potential Stormwater Inclusion/Goals
Saugahatchee Creek Watershed Past, Present, & Future	Report on the geography, ecology, history, land use, protection efforts, studies, and future course of the Saugahatchee Watershed written as a precursor to the Watershed Management Plan.	Water Resource Management	Background information on the watershed.
Saugahatchee Watershed Management Plan	Watershed Management Plan to address the sources and potential solutions to nutrient load reductions of nutrients and organic enrichment in the Pepperell Branch and Saugahatchee Embayment, which are the 303(d)-listed segments. Sediment and erosion are also addressed. Nineteen strategies that address Urban, Rural and Assessment/Evaluation aspects of a plan were developed and scheduled to be implemented over an eight-year period.	Water Resource Management	Goals for water quality overlap with GI/LID goals and are further discussed in the Phase I and Phase II Implementation Reports (rows below). This report could be used to identify additional projects.
Saugahatchee Watershed Management Plan Phase I Report	Outlines the first phase (2007-2010) of implementing the Saugahatchee Watershed Management Plan. The northern portion of the City of Auburn is within this watershed, which extends to the north and west. BMP installation, stream channel/floodplain restoration, and public outreach projects and their outcomes are outlined.	Water Resource Management	This report could be used to identify additional restoration and public education projects.
Saugahatchee Watershed Management Plan Phase 2 Report	Outlines the second phase (2011-2013) of implementing the Saugahatchee Watershed Management Plan. The northern portion of the City of Auburn is within this watershed, which extends to the north and west. BMP installation, LID SCM development and review, and public outreach projects and their outcomes are outlined. Pollutant load comparisons are provided.	Water Resource Management	This report could be used to identify additional restoration and public education projects and provides quantitative water quality data.
Saugahatchee Creek Greenway & Blueway Project Trail and Easement Alignment Phases I & II Map	Map showing proposed 5-mile trail along Saugahatchee Creek showing existing 20' sanitary sewer (SS) easements, proposed greenway alignment, Saugahatchee Creek, floodway, floodplain, stream buffer, surrounding streams, parcels, proposed blueways, proposed pedestrian bridge, proposed put-in/take-outs, and proposed pocket parks.	Parks	Public projects should show continuity with trails and can use this resource.
Parkerson Mill Creek Watershed Management Plan	The City of Auburn is within this watershed and the waterway has a Total Maximum Daily Load (TMDL) for fecal coliform. Land use descriptions, creek channel and analytical data and watershed goals are included.	Public Works	Watershed goals are to meet TMDLs. This report includes useful quantitative data.
Moore's Mill Creek Watershed Management Plan	Summarizes the assessment of Moore's Mill Creek alterations, stream and bank conditions, and erosion and sedimentation. Management recommendations and stream restoration projects are recommended. The eastern portion of the City of Auburn is within this watershed, which extends to the east and south.	ADEM	This report could be used to identify potential water quality and restoration projects.
Presentation: Water Resource Management: Our Local Water Resource	PDF of PowerPoint presentation given by the Water Resource Management explaining the water cycle, source water, watersheds, water quality concerns and water monitoring to the general public.	Water Resource Management	Background information could be used for future educational events.
Auburn 2020	Report outlining the City of Auburn's vision for its growth. Goals include: supporting all City departments, constructing a community learning center, periodic updates to the land use plan, purchasing property for industrial parks, building additional parking facilities downtown, expanding mass transit, updating the master street plan every 3 years, establishing sidewalks and bike paths, developing additional drinking water sources, upgrading the wastewater treatment plant, acquiring and developing additional parks/green spaces, acquiring and developing a new cemetery.	City Council	Some visions, such as parks and trails, overlap with GI/LID goals, however there are no stormwater references in this document. It was due to be updated prior to 2000 and future updates could include more GI/LID elements.
Auburn Downtown Master Plan	Report outlining the City of Auburn's vision for enhancing and growing downtown Auburn. The report includes demographic information, neighborhood and land use descriptions, potential growth areas, potential transportation improvements, and studies.	Planning	This plan could be used to identify potential GI/LID projects and stakeholders. GI/LID elements could be incorporated to add more benefits to parking, trails, transportation, and other projects.
List of Streetscape and Developments with Approved Conditional Uses	List of five locations where streetscapes are located. List of 50 addresses, parcel numbers, and land uses and the associated public notices with maps where conditional uses for zoning districts have been approved since 10/2016.	Planning	Provides additional information about mixed use and conditional use projects in the City of Auburn.
Presentation: Ballard Partnerships Presentation	PowerPoint from Alabama Stormwater Symposium on the partnership between Auburn University, Portland State University, and the City of Auburn on the status of local waterways, GI, and waterway monitoring.	Water Resource Management	Background information could be used for future educational events. Identifies potential stakeholders.
Water Resource Management Design and Construction Manual	Requirements for engineering design and construction of projects within the City of Auburn and its planning jurisdiction, for drinking water, wastewater, and storm water quality management. Includes stormwater quality, erosion, and sediment control requirements. Performance characteristics for each of the general and limited application control practices (stormwater wetland, bioretention area, wet detention basin, grassed swale, infiltration devices, buffers, permeable pavement, sand filter, filter strip, manufactured BMP systems, and dry extended retention basin) are included.	Water Resource Management	Provides City of Auburn's current post-construction requirements and can be built upon for LID manual.

Reviewed Document	Description	Owning Department	Overlapping/Potential Stormwater Inclusion/Goals
Pilot Project Background			
2004 Greenspace Greenway Master Plan	Map showing City limits, parks, future parks, green areas, greenways, greenspace, golf courses, state parks, major streams and rivers, streets, floodplains, minor streams and drainage, existing bike paths, proposed bike paths, growth areas, and City property.	Parks and Recreation	This map shows connectivity of greenspace and the City of Auburn values having these amenities connected.
PR Master Plan Projects	Concept maps of 17 projects to improve existing City parks.	Parks and Recreation	Identifies some potential public GI/LID pilot projects and creates a starting point for review of public projects for potential use of GI/LID.
List of Storm Drain Problem Areas	List of nine locations, roads, ponds, bridges, and culverts where there are storm drain problems.	Water Resource Management	Identifies some potential public GI/LID pilot projects and creates a starting point for review of public projects for potential use of GI/LID.
GIS			
Available GIS Layers	Shapefiles of buildings, City limits, City properties, edge of pavement, hydrology, land use, soils, open water, parcels, parking lots, and street names were collected. A geodatabase containing contours at 1-foot intervals was collected. Aerial photography was collected in both low-resolution (SID) and high-resolution (TIFF) formats.	Information Technology	Valuable information for developers and reviewers. Look for opportunities to identify, track, and maintain GI using GIS as a tool.

Potential Green Infrastructure Framework and Road Map

Creating the initial green infrastructure Framework and Road Map involved the review of the above documents, the existing stormwater program, and the completion of staff questionnaires and interviews. All of this information was compiled and organized as follows: Summary of the Current Post-Construction Stormwater Quality Program, Recommendations for Incorporation of Green Infrastructure into the Post-Construction Stormwater Quality Program, Comprehensive review of ordinance, policies, and processes, and identification of areas of opportunities and recommended changes. At the end of this section, a master table (**Table 4**) is provided which summarizes the complete set of recommendations which is to serve as the overall Green Infrastructure Road Map.

Current Stormwater Program

The City of Auburn has been compliant with NPDES Phase II Stormwater Regulations since they were implemented by the State in 2003. The City of Auburn applied for and received a NPDES permit for stormwater discharges from the Alabama Department of Environmental Management (ADEM) on May 14, 2003. This five-year permit first expired in March 2008, and was extended until renewed in 2011 (final modifications adopted in February 2012). The current permit was reissued September 6, 2016 and became effective October 1, 2016.

Post-construction stormwater quality management is addressed by the permit through requiring the City of Auburn to implement and enforce a program to address stormwater runoff from new development and redevelopment projects. Relevant to GI/LID specifically, the City's post-construction program must include structural and non-structural controls including GI/LID and an evaluation of local codes to identify regulatory impediments to the installation of GI/LID.

As local governments work to include GI/LID elements in their post-construction stormwater programs, some are adopting available State or regional guidance, such as *The Alabama LID Handbook*, some modify their local codes to refer to guidance and manuals developed by other communities, and some chose to develop their own city specific manuals (i.e., Birmingham, AL, Augusta, GA). Regardless of a local government's source of GI/LID design guidance, minimum performance standards must be defined locally to ensure that site designers and plan reviewers clearly understand local requirements. In turn, this understanding allows the permitted MS4 to clearly show compliance with NPDES Phase II permit requirements. An example of a GI/LID-focused stormwater quality performance standard is as follows.

- Runoff reduction for 1.0 inch of rainfall over the development using GI/LID. If the entire 1.0 inch cannot be managed using GI/LID, then the remaining runoff from the 1.2-inch event must be treated to remove at least 80% of (Total Suspended Solids) TSS.

The rainfall amounts stated are examples only and may not equate exactly to the 2-year, 24-hour design storm predicated in Auburn's permit. Regardless, this example standard establishes several key points: 1) runoff (i.e., volume) reduction using GI/LID as the preferred stormwater quality management approach; 2) GI/LID is further encouraged through the use of a lower rainfall depth when the preferred approach is used; and 3) that a protective level of stormwater quality management must still be done even when GI/LID cannot, or will not, be used. The latter is established through the 80% TSS Removal standard, which is a well-established, "standard of practice" water quality protection criterion used across the southeast United States. In other words, 80% TSS Removal is an adequate water quality protection standard where GI/LID is impracticable due to physical site restraints.

Beyond a jurisdiction-wide GI/LID standard, many jurisdictions include other standards for stormwater quality or quantity control and the protection of special condition streams or watersheds. Beyond the GI/LID standard expressed above, an example of a graduating set of stormwater standards that could be applied in Auburn include:

- Stream channel/aquatic resource protection provided by one of the three options:
  - 24-hour extended detention storage of the 1-year, 24-hour return frequency storm event;
  - Erosion prevention measures such as energy dissipation and velocity control; or
  - Preservation of the applicable stream buffer;

- Overbank flood protection in the form of controlling the post-development peak discharge rate to the predevelopment rate for the 25-year, 24-hour storm event; and
- Extreme flood protection in the form of controlling the 100-year, 24-hour storm event.

The example demonstrated above would be a relatively abrupt change to the City of Auburn's current requirements. Further, such standards may not be relevant or applicable to all areas of Auburn. For example, difficulties with small-sized extended detention outlets have led many jurisdictions to require stream channel protection only where streambank instability is apparent. Regardless, a graduating set of requirements such as those above can be phased in to apply to all applicable new and re-development sites.

In contrast with the example provided above, the City of Auburn's current post-construction program requires treatment of the volume of stormwater generated by the first 1.2" of rainfall (hereinafter, the treatment volume). The post-development stormwater quality criteria applied to this treatment volume vary by watershed and only apply to the City of Auburn's Lake Ogletree source water watershed, any watershed with a finalized TMDL, and/or any watershed of a Waters of the State listed on the most current Alabama Department of Environmental Management's 303(d) List of Impaired Waters. Currently, this means that stormwater quality controls are not implemented across Auburn's entire permitted jurisdiction, in that they are applicable only within certain watersheds (see **Figure 5** below). It is important to note that the NPDES Phase II permit applies to the entire permitted jurisdiction, so there should be some level of post-construction stormwater quality management outside of these key watersheds. In each specific watershed, the developer must utilize the City of Auburn's Site Development Review Tool or other method approved by Water Resource Management staff to demonstrate the required pollutant removal efficiencies. The City of Auburn will waive these criteria for any proposed developments utilizing the City of Auburn's Conservation Subdivision Regulations or can demonstrate that a Low Impact Development approach (as detailed in the Low Impact Development Handbook for the State of Alabama) has been employed for the development.

Development in two watersheds: Chewacla and Uphapee, are not required to meet the City of Auburn's water quality requirements. Some projects therefore need only to comply with requirements for peak flow. **Figure 5** provides a graphical depiction of the City of Auburn's current options for meeting stormwater requirements.

Current options for meeting stormwater requirements

Waivers for New Development <1 acre are available for improving existing site stormwater condition

Waivers for Redevelopment area available for improving existing site stormwater condition

Provide WQv treatment for the first 1.2" Rainfall Water Quality Criteria based on watershed:

Saugahatchee Watershed*
Removal of 50% nutrients (Total P)
Lake Ogletree Watershed*
Removal of 40% nutrients (Total P) and 80% TSS
Parkerson Mill Watershed*
Removal of 60% pathogens (E.coli)/P
**see watershed map*

Use AL LID Manual (this option promotes GI/LID and waives other requirements)

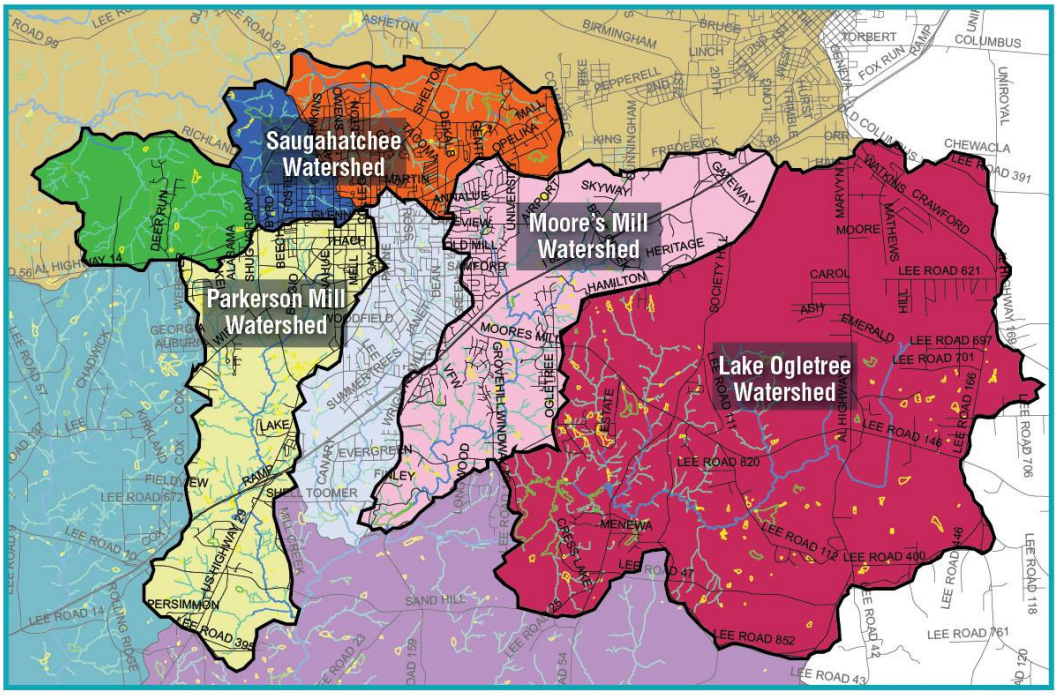


Figure 5: Current options for meeting stormwater requirements and map of Auburn's watersheds.

Potential Green Infrastructure Stormwater Quality Framework

The City of Auburn is not alone in facing a transition from minimal consideration of stormwater quality in site designs to the inclusion of GI/LID for stormwater management. Requirements for GI/LID are turning up in many NPDES-MS4 permits and many local governments across the United States are revising their requirements accordingly. Due to the lack of specific standards, communities are taking one of three approaches: 1) they have adopted a wait and see posture, making no changes to the water quality portion of the design standards and waiting for more guidance from USEPA or a local regulatory authority (note, this is not an option in Alabama due to the 2017 general permit adoption); 2) they have added a voluntary use of GI/LID as an alternative to more standard design approaches, such as the mandatory construction of TSS removal facilities; or 3) they have instituted a mandatory GI/LID approach through the adoption of local or regional ordinances and design criteria.

Option 2 (voluntary use of GI/LID) is further described through the example of Nashville, Tennessee's GI/LID program. Nashville used an 80% TSS Removal standard prior to incorporation of GI/LID into the design process as a voluntary standard. This approach was used in Nashville for the first two years of GI/LID program initiation prior to the use of GI/LID becoming mandatory to meet the State of Tennessee's NPDES MS4 permit.

Under the voluntary approach, Nashville site designers could choose between the GI/LID or 80% TSS Removal controls to satisfy the stormwater quality requirement. While the familiarity of the 80% TSS approach was attractive to many, the GI/LID approach began to gain traction with both real-time and on-line training (https://www.nashville.gov/Water-Services/Developers/Low-Impact-Development.aspx), and the growing realization that for many sites the stormwater quality requirement could be satisfied using the same parcel spaces that were required to be set aside for green space (parking islands, side yards, etc.).

The advantage of beginning with a voluntary GI/LID standard is that those developers and designers who wanted to try the approach could do so while the rest of the development community retained their standard 80% TSS Removal approach. Nashville began to encourage this approach through the use of such incentives as prioritized plans review, pre-development review and input meetings, individualized training, "premium" level assistance, cost sharing to encourage the site as a demonstration project, and waiver of plans review and inspection fees, etc. In the first two years of the voluntary approach, Nashville found that 23% of applicants chose the GI/LID approach. Another advantage of this approach can be realized if the City of Auburn creates a culture around GI/LID where mistakes are seen as shared learning experiences without penalty and successes are recognized and rewarded.

Wood recommends that the City of Auburn consider implementing a voluntary approach where GI/LID is encouraged and possibly incentivized over 80% TSS Removal, with the latter being the minimum required standard. In contrast, the City of Birmingham is contemplating adoption of an approach based on Nashville's example where a site designer is required to consider GI/LID on every development, but can default to 80% TSS Removal where he/she feels GI/LID is unfeasible. While Birmingham's proposed approach doesn't require GI/LID, it certainly forces the site designer to actively consider green approaches and document decisions made in the stormwater design plan.

The flow chart figure shows the logic steps that should be followed for effective implementation of a connected set of GI/LID and 80% TSS Removal performance standards. The steps shown in the flow chart can be predicated by policies that comprise local government stormwater design process or can be implemented through a specialized design calculation as was done in Nashville via the Annual Rv Method (Rv is a measure of volume capture). Regardless, following the step-wise approach requires the developer to first look at site layouts that reduce impact, then natural approaches, and lastly, structural treatment. This step-wise approach can be tailored to fit with the following three-step philosophy that the City of Auburn expressed interest in theming the overall program with: 1) avoiding land development in environmentally sensitive areas, 2) minimizing the project's effect on stormwater through thoughtful site layout and planning, and 3) mitigating for the development's negative stormwater quality and quantity results through incorporation of green infrastructure.

Figure 6 provides a potential framework for the City of Auburn's post-construction stormwater program. Note that the rainfall amounts stated in the figure (e.g., 1 inch, 1.2 inches) need further research. Wood believes that further

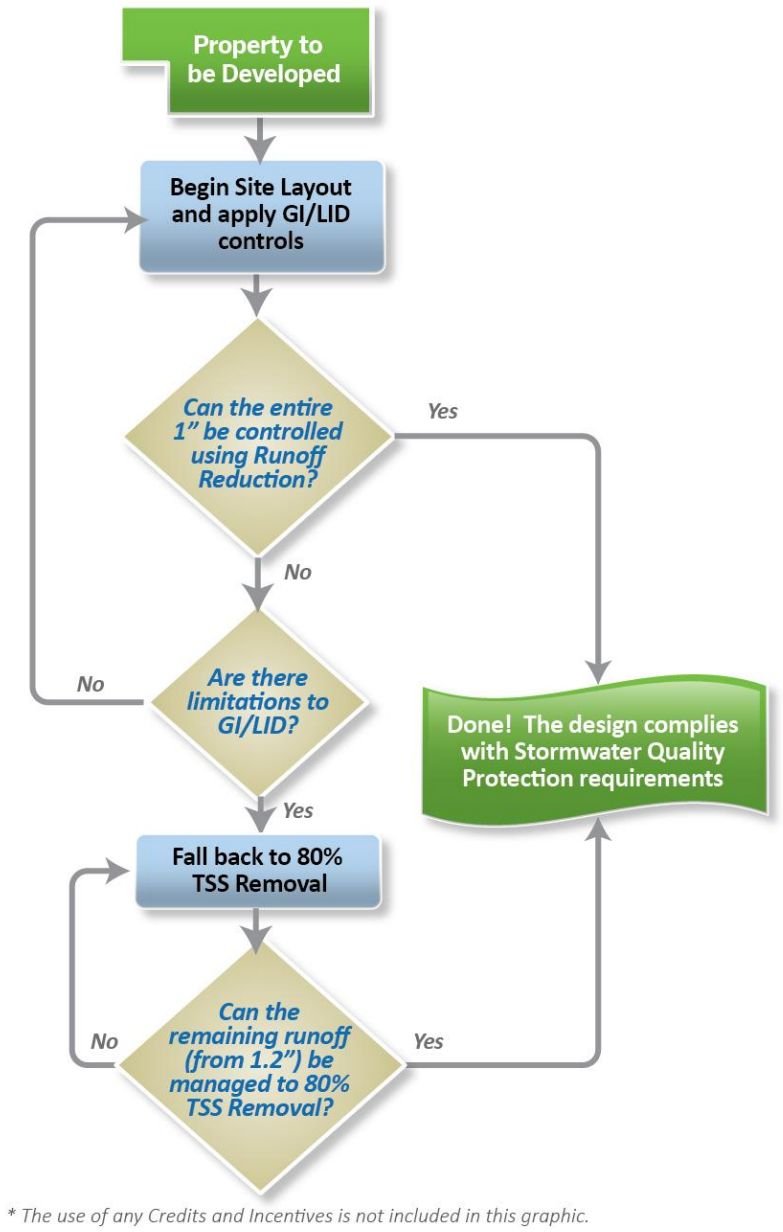


Figure 6: Potential Post-Construction Framework

discussion with ADEM is needed to resolve inconsistencies between the rainfall intensity basis included in Auburn's permit versus the rainfall depths (1.1 to 1.2 inches) that are common in ADEM's permits issued elsewhere in the state.

The framework for stormwater quality illustrated in **Figure 6** allows the local government to move away from the permit's standard of maximum extent practicable. At the local government level, this ambiguous standard typically results in confusion and very little water quality protection. Rather, the framework provides a set of definitive performance standards (see the three boxes on the second row of the figure) that protect water quality and provide the flexibility to avoid volume reduction controls where they are not practicable. The primary standard requires the use of volume reduction controls (green infrastructure), while a secondary standard is applied when such controls are impracticable. Thus, all applicable developments must meet a performance standard that is clearly defined, can be demonstrated on design plans, and objectively evaluated by plan reviewers.

Movement of a stormwater quality design from the primary standard (left box, second row) to one of the secondary standards (middle and right boxes, second row) is predicated on the feasibility of green infrastructure on the site. A volume reduction approach using green infrastructure sets the basis for the primary (or preferred) standard. When volume reduction of the entire 1 inch cannot be achieved, the site designer can then "fall back" to one of the secondary standards. If some, but not all, of the required 1-inch volume can be managed by green infrastructure, then the performance standard in the middle box is used. It credits the amount of volume captured onsite by requiring further treatment of *only the remaining stormwater quality volume*. If volume reduction controls are entirely unfeasible, then the performance standard in the right box is used, which is an industry standard for pollutant removal. Note that green infrastructure is further encouraged through the use of a lower rainfall amount (1 inch) in the primary standard and a higher amount (1.2 inches) for the secondary standards.

With this primary-secondary performance standard, the practicability of green infrastructure on a development site then becomes the devil in the details. If practicability is left undefined by the local government, stormwater

regulations remain ambiguous. The local government can minimize this problem to a large degree by adopting stormwater policy that recognizes the circumstances in which green infrastructure is unfeasible. Examples of such conditions being considered for use in the City of Birmingham's proposed stormwater policy include:

- Natural physical conditions where infiltration of stormwater is unwise or overly limited (i.e., shallow bedrock, hardpan layers, high water table, steep slopes, karst, and highly contractive/expansive soils). Note that this limitation doesn't necessarily include poorly drained soils, as green infrastructure practices can be placed in such areas, albeit with underdrains.
- Areas where groundwater should be protected, such as wellhead protection zones.
- Areas where soil contamination is present or suspected.
- Conflicts with utilities, or with cultural, historic or archeological significance.
- Developments where the required maintenance or operation of green infrastructure practices will conflict with the future land use. For example, a cistern proposed for a highly impervious gas station development seems suspicious. The plan reviewer should ask how the cistern will be operated so that adequate storage capacity is available for the next rainfall.

Evidence of these green infrastructure limitations can be provided on stormwater design plans through maps, soil analysis, or narratives as appropriate for each limitation. The local government's historical knowledge of such issues should be sufficient where data is already known. For example, a complaint history of flooded basements should be enough for plan reviewers to prohibit infiltration-based practices in these areas without requiring the site designer to provide soil or subsurface analysis. To the degree possible, the local government should provide data where it is available (e.g., known or suspected karst areas).

Process, Policy, Code and Ordinance Review and Recommendations

City codes, ordinances, design and construction standards and details, processes, and other guidance and regulatory documents were reviewed according to the 2017 Center for Watershed Protection (CWP) Code & Ordinance Worksheet. Findings from this review and subsequent discussions with City staff were organized to focus on how well the documents lined up with the CWP Principles. CWP Principles are provided below along with discussion of related findings and areas of opportunity.

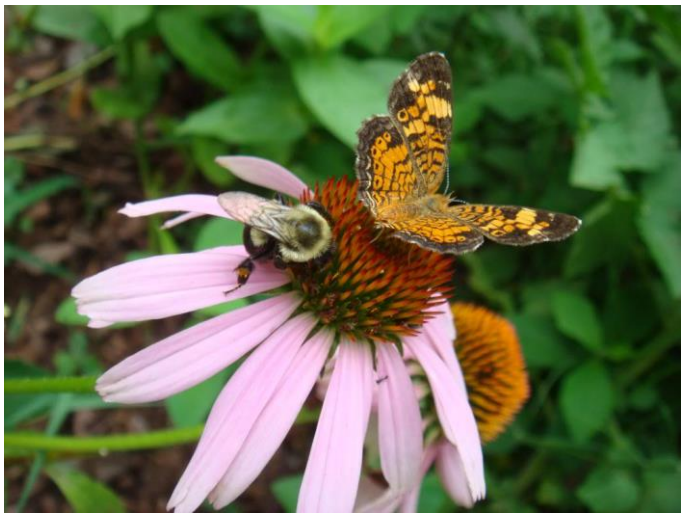


Figure 7: Many green infrastructure practices use native plants, which provide benefits to the ecosystem and help enhance the urban environment. However, often times municipal code and ordinances are in conflict with green infrastructure practices and need to be revised to remove barriers to implementation.
(Source: AL LID Handbook).

Street Width

***Principle**: Design residential streets for the minimum required pavement width needed to support travel lanes; on-street parking; and emergency, maintenance, and service vehicle access. These widths should be based on traffic volume.*

The recommended pavement widths for low volume roads (<400 Average Daily Traffic (ADT)), where bicycles are not present is between 18 and 22 feet. Chapter 21 of the Auburn Code of Ordinances requires a minimum width of 27 feet for minor streets. However, when sidewalks are present, the Standard Details for Streets provides a pavement

width of 22 feet for typical street cross sections with sidewalks. Conservation subdivision requirements also allow for a minimum pavement width of 22 feet.

The City of Auburn has included in the Public Works Design and Construction Manual curb extensions that narrow the roadway as potential solutions for traffic calming. These techniques (pinch points and chicanes) can also be utilized with redevelopment of existing subdivisions to create space for green infrastructure interventions. The codes appear to be silent on the use of these features for stormwater management.

The Water Resource Management Design and Construction Manual describes permeable pavements as being suitable for residential street parking lanes, along with other areas.

Also, design criteria for permeable pavements is found in sections 7.2.2, 7.2.3, and 7.2.5 of the Auburn Public Works Design and Construction Manual. The manual prescribes a single runoff coefficient and curve number for "permeable pavement". Permeable pavement is also referred to in 7.2.5 as "porous" or "pervious" pavement. A curve number of 85 is required for designs where NRCS Curve Number methodology is utilized to estimate runoff. A rational runoff coefficient of 0.70 is required where the Rational Equation is applicable.

These numbers appear to be in reasonable alignment with other municipal design criteria across the United States. However, these criteria may not always be appropriate for all types of permeable, porous, and pervious pavements and products that can be considered for use in Auburn. Modern design guidance has begun to provide more product or material-specific guidance and requiring that manufacture recommendations be followed. Some guidance provides equations for calculating custom curve numbers based on pavement type and other manuals or policy documents provide expanded tables or design tools that include a more comprehensive list of pavement types and products. Some sources suggest staying with the curve number or rational coefficient concept, while others see the permeable pavement as serving more as an inlet to an underground storage/infiltration bed, and suggest that the system be modeled as such. Also, while the criteria offered by Auburn today is sufficient, it is recommended that this area of design be further studied in order to provide the most appropriate criteria for properly modeling and incentivizing drainage systems that utilize permeable pavements.

> ***Areas of Opportunity**: The City of Auburn could potentially reduce the area of impervious cover associated with subdivision development by reducing the minimum pavement widths stated in the City Code from 27 feet to 22 feet. A combination of permeable on-street parking lanes with bioretention provided in the extended curb areas could effectively reduce the area of imperviousness associated with residential streets even further. Highlighting these opportunities in City guidance and subdivision review processes and checklists is recommended.*

Street Length

Principle: Reduce total length of residential streets by examining alternative street layouts to determine the best option for increasing the number of homes per unit length.

No City regulatory or guidance documentation was identified as promoting or identifying reduced neighborhood street lengths as being beneficial to water quality. Potential provisions that may result in a more compact street network may include narrower allowable lots and features associated with open space/conservation developments. Traditional Neighborhood Development promotes walkability and connectedness and typically results in reduced street lengths.

> ***Areas of Opportunity**: City development and guidance could further highlight the desire to reduce impervious cover by also addressing street length. Adopting a development approach such as Traditional Neighborhood Development and incentivizing implementation where appropriate is recommended.*

Right-of-Way Width

Principle: Wherever possible, residential street right-of-way widths should reflect the minimum required to accommodate the travel-way, the sidewalk, and vegetated open channels. Utilities and storm drains should be located within the pavement section of the right-of-way wherever feasible.

The required minimum right-of-way width for residential streets in the City of Auburn is 50 feet. Positive elements found related to street right-of-way use include: storm and sanitary sewer placement beneath the pavement as a general rule; and sufficient rooting space for street trees (6' minimum) being required between the back of curb and sidewalks.

> ***Areas of Opportunity**: A 45-foot minimum right-of-way width is recommended to promote minimized clearing during development and maximizing long-term land use. Also, where appropriate, allowing additional utilities beneath the roadway can produce a more compact development footprint.*

Figure 8: Installation of infiltration area in median in Auburn University.

Cul-de-sacs

Principle: Minimize the number of residential street cul-de-sacs and incorporate landscaped areas to reduce their impervious cover. The radius of cul-de-sacs should be the minimum required to accommodate emergency and maintenance vehicles. Alternative turnarounds should be considered.

While the City of Auburn codes and policies do not necessarily encourage minimizing the use of cul-de-sacs, they do allow for the minimization of the impervious area created by these street features. A minimum radius of 44 feet is required for traditional designs (less than the recommended 48' minimum), and alternative turnarounds such as hammerheads and loop streets are also allowed. Landscaped islands and planters are allowed in conventional subdivisions and required in conservation developments.

Codes do not address the use of landscape islands in this setting being used as stormwater management areas. A green space or rain garden used inside of a loop street may not be counted toward open space requirements in a conservation subdivision.

> ***Areas of Opportunity**: City development and guidance could further highlight the desire to reduce impervious cover by promoting a reduction in cul-de-sacs. In addition, an allowance for landscaped islands being used as stormwater management features, along with granting open space credits should be considered to maximize the use of this vegetated space*.

Vegetated Open Channels

Principle: Where density, topography, soils, and slope permit, vegetated open channels should be used in the street right-of-way to convey and treat stormwater runoff.

City codes allow for vegetated channels where density, topography, soils, and slope permit. Codes do not mention specifically the incorporation of stormwater management practices within or in combination with these features.

> ***Areas of Opportunity****: It is recommended that the City of Auburn modify codes to bring attention to the potential for vegetated swales being utilized for stormwater management, in accordance with technical guidance given in the design manuals.*

Figure 9: Bioretention featured at the Gay Street Parking Lot in Auburn, AL.

Parking Ratios

Principle: The required parking ratio governing a particular land use or activity should be enforced as both a maximum and a minimum in order to curb excess parking space construction. Existing parking ratios should be reviewed for conformance, taking into account local and national experience to see if lower ratios are warranted and feasible.

Standard parking requirements are set as minimums only and do not cap the number or size of spaces serving a development. They do not appear to be based on local parking demand, but rather a prescribed number of spaces for the types of businesses being served.

> ***Areas of Opportunity****: The City of Auburn could potentially reduce the impervious area associated with parking areas by setting both minimum and maximum numbers of parking spaces allowed. A study of the source and of the requirements should be considered to ensure the appropriateness and applicability of the prescribed limits. The Institute of Traffic Engineers, the Urban Land Institute, and the National Parking association provide industry standards that can be adjusted to reflect local characteristics.*

Parking Codes

Principle: Parking codes should be revised to lower parking requirements where mass transit is available or enforceable shared parking arrangements are made.

Shared parking is allowed for up to 20% of the required parking if sharing lots are side-by-side. The codes are silent on incentives or reductions when mass transit or bike/car share services are available nearby.

No off-street parking is required in the urban core, which has on-street parking. No more than 50% of urban core property in the urban core can be utilized for drives and parking (with exception of parking garages).

Parking minimums are required to be met for each phase of a project. The Planning Director may also stipulate that all landscaping and buffer yards be provided during the first stage of development, even if some buffer yards lie outside of the limits of that stage.

> ***Areas of Opportunity****: Transit Oriented Development can further reduce parking demands, as long as required parking ratios reflect the benefits of fewer vehicles being driven and requiring*

space to park. Also, shared parking is most effective at reducing the number of required spaces when destinations have different peak visitor periods during the day or week, and where destinations share patrons. The current reduction incentives for shared parking could be enhanced by requiring consideration of these factors.

Parking Lots

Figure 10: Permeable Pavers featured at the Gay Street Parking Lot in Auburn, AL

Principle: Reduce the overall imperviousness associated with parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, and using pervious materials in spillover parking areas.

The Water Resource Management Design and Construction Manual describes permeable pavements as being suitable for several types of driveways, paths, and parking areas. Both primary and spillover parking areas may incorporate the use of permeable materials. However, the Department of Public Works Construction and Design Manual states that permeable pavements are NOT recommended for parking lots with a large percentage of turning movements.

City codes and ordinances allow for a minimum parking stall width and length of 9 feet by 18 feet, meeting the recommendations for reducing impervious cover in parking areas.

***Areas of Opportunity**: To further reduce the potential impervious area, the City of Auburn should consider including a fixed proportion (e.g., 15%) of parking spaces at larger commercial parking lots with smaller dimensions for compact cars. Also, in addition to highlighting where pervious pavements should not be used, codes and regulations could be enhanced by promoting the use of pervious pavements of appropriate materials for appropriate applications.*

Structured Parking

Principle: Provide meaningful incentives to encourage structured parking (vertical parking structures, such as parking garages) to make it more economically viable.

The codes are silent in terms of encouragement of structured parking to serve new and redevelopment projects.

***Areas of Opportunity**: The current language and City approach may be appropriate for the City of Auburn's current size and density. However, in urban areas, incentives for structured parking should remain an option to decrease the overall costs to developers, and for the social, economic, and environmental benefits to the City of Auburn.*

Parking Lot Runoff

Principle: Wherever possible, provide stormwater treatment for parking lot runoff using bioretention areas, filter strips, and/or other practices that can be integrated into required landscaping areas and traffic islands.

The City of Auburn codes require that a minimum percentage of a parking lot be landscaped based on the number of required parking stalls. The Water Resource Management Design and Construction Manual also offers

bioretention areas as being appropriate for parking areas and specifically highlights parking lot islands as an application example. Filter strips are suggested for several applications as pretreatment for online systems.

Minimum dimensions of parking islands appear to be sufficient to support the growth of large trees (9' minimum). It appears that vegetated islands will count toward required landscape minimums even if the island is utilized for stormwater management. A minimum number of trees is required in parking lots. According to the Planning Department, the minimum number of trees would still be required and could be fulfilled with trees within stormwater management areas and/or other landscaping.

***Areas of Opportunity**: The codes could be more specific in their endorsement of flush curbs, curb cuts, and depressed landscaped areas for direction of runoff into vegetated landscaped islands or other runoff reduction practices. Also, the current greenspace dimensions shown on the Standard Details for streets should be brought into alignment with other minimum dimensions for these areas. The standards currently show a dimension of 5'-10' Section 5.2.4.2 of the Auburn Public Works Design and Construction Manual requires the use of street curb and gutter where street gradient exceeds 5%. Flush curbs have been observed in successful applications along paved areas where gradients exceed 5%. As an example, recent renovations to Mell Street on the Auburn University campus include inverted medians with no curb in areas where the street gradient appears to exceed 5%.*

It is recommended that this limitation be revisited and modified to further promote awareness of the option of utilizing no curb and flush curb pavement cross sections.

Figure 11: A parking lot with flush curbs draining to a trench in a depressed landscaped area.
Auburn University Research Park
(Source: AL LID Handbook).

Open Space Design

Principle: Advocate open-space development that incorporates smaller lot sizes to minimize total impervious area, reduce total construction costs, conserve natural areas, provide community recreational space, and promote watershed protection.

The concept of a conservation subdivision is in alignment with the City of Auburn's goal for development to avoid, minimize, then mitigate impacts to the environment. Conservation Subdivisions, which include open-space requirements, are allowed by the City of Auburn and incentivized. While Article VI of the Subdivision Regulations addresses Conservation Subdivisions completely and clearly, the concept and its benefits to the developer do not appear to be promoted extensively in other documentation. For example, there is no mention of conservation subdivisions in the Development Review Team (DRT) processes, submittal requirements, or checklists.

The conservation subdivision regulations allow and encourage the clustering of structures and allow for greater flexibility and creativity in subdivision design. The conservation subdivision also provides for reductions in minimum lot and yard sizes and dimensions when compared to conventional subdivisions.

A step-wise method is provided for the design of a conservation subdivision. The process identifies and sets aside potential conservation areas prior to identification and planning for house sites, streets and trails, and lot lines.

The stated purposes of the conservation subdivision include: to promote efficient uses of the land to protect and preserve environmentally sensitive areas and the City of Auburn's potable water supply source; to preserve in perpetuity unique or sensitive natural resources such as ground water, floodplains, wetlands, streams, watersheds, woodlands, and wildlife habitat. The regulations do not mention as a stated purpose or goal the reduction of impervious cover.

The required open space in conservation subdivisions is at least 50% of the gross area of the subdivision. Currently, existing conventionally restricted areas such as wetlands, floodplains, stream buffer zones, and steep slope areas may be considered conservation areas.

> ***Areas of Opportunity****: The Conservation Subdivision concept should be publicly endorsed and promoted by the City of Auburn at every opportunity. The regulations should be offered as a first option and be given priority in submittal and review processes.*

Also, to be more encouraging of open-space design, the regulations could be clarified to require 50% of the buildable portion of the site. A reduction in impervious area should be listed as one of the purposes and goals of the conservation subdivision.

Figure 12: Stream restoration projects in and around Auburn serve to increase water quality, improve the quality of greenspace, and provide healthy stream buffers.

Setbacks and Frontages

Principle: Relax side yard setbacks and allow narrower frontages to reduce total road length in the community and overall site imperviousness. Relax front setback requirements to minimize driveway lengths and reduce overall lot imperviousness.

The codes allow for "flag lots," with conditions, and provide avenues for variances for irregularly shaped lots and setback and frontage requirements. However, they do not appear to provide much flexibility on the reduction of minimum setbacks and road frontage widths.

> ***Areas of Opportunity****: Consider relaxing minimum setbacks and road frontages to allow for potential decreases in the lengths of streets, driveways, and sidewalks, resulting in an overall reduction in total site imperviousness.*

Sidewalks

Principle: Promote more flexible design standards for residential subdivision sidewalks. Where practical, consider locating sidewalks only on one side of the street and provide common walkways linking pedestrian areas.

The City of Auburn design standards require a five-foot minimum width if a sidewalk is within two feet of the back of curb in a street or parking environment. The minimum is four feet otherwise. Codes also allow the City of Auburn to consider the creation of alternating sidewalk/shared use path system in lieu of sidewalks. Such pedestrian/bike networks must incorporate well-connected sidewalks and paths/trails that link each residential lot with on-site open space, recreational facilities and other amenities within the development site. A sidewalk/shared use plan for an entire development must be submitted to the City Engineer for approval.

Shared use paths may be constructed of pervious concrete and other porous materials provided the runoff through the material will not be directed towards the subgrade of the traveled lane portion of the roadway.

> ***Areas of Opportunity**: An official Complete Streets policy could help to balance the needs for mobility and a reduction of imperviousness associated with pedestrian and bicycle facilities.*

Driveways

Principle: Reduce overall lot imperviousness by promoting alternative driveway surface and shared driveways that connect two or more homes together.

Shared driveways are encouraged by the City of Auburn and may be required for access management purposes. It is unclear if two-track driveways (paved areas only under the wheel paths) and pervious materials can be used as a driveway surfacing. Current standard details show only concrete and a solid minimum width of ten feet.

> ***Areas of Opportunity**: The impervious area of lots could be further minimized by reducing the currently required minimum driveway width of ten feet to nine feet. Also, the use of alternate materials such as pervious pavements, and alternative configurations such as two-track, should be considered for inclusion in codes as being allowed where appropriate.*

Open Space Management

Principle: Clearly specify how community open space will be managed and designate a sustainable legal entity responsible for managing both natural and recreational open space.

Public open space in the City of Auburn must be platted and dedicated for public use. Open space may be owned and administered by one or a combination of private or public entities. Open space may be preserved as a conservation easement, greenway, lot, or other recorded parcel. Methods of administration and ownership may include: homeowners' associations; transfer to private conservation organizations; an individual or trust; and dedication to the City of Auburn. Activities within open spaces of conservation subdivisions shall be restricted in accordance with regulation and in perpetuity through the use of a legal instrument.

For conservation subdivisions, a long-term management plan is required and is a part of a required Maintenance Plan for open spaces. Estimates of on-going operation and maintenance funding requirements, and sources of funding are required as a part of the Maintenance Plan.

Open space associated with conventional subdivisions requires similar identification and obligations for perpetuation, maintenance, and administration through an open-space plan submitted as a part of a site plan or subdivision approval.

Lots not directly joining open spaces in conservation subdivisions must be provided with safe, convenient access to the open space. Connectivity of open spaces is also encouraged with approval of conventional subdivision submittal and approval.

***Areas of Opportunity**: Open space requirements could be enhanced by including standards that require interconnections, prioritized lists of resources to be conserved, and access standards.*

Rooftop Runoff

Principle: Direct rooftop runoff to pervious areas such as yards, open channels, or vegetated areas.

Examples within the Water Resource Management Design and Construction Manual show rooftop runoff being disconnected from the storm sewer system and diverted to vegetated channels and other stormwater management features.

***Areas of Opportunity**: The manual and other documents could be enhanced in the area of rooftop runoff management with the specifically stated allowance of temporary storage of rainwater in storage tanks (e.g., rain barrels or cisterns). Local building and plumbing codes could also allow and provide guidance for the use of harvested rainwater for exterior uses such as irrigation and non-potable interior uses such as toilet flushing. Other enhancements could include guidance for and the regulation of the use of green roofs.*

Buffer Systems

Principle: Create a variable width, naturally vegetated buffer system along all perennial streams that also encompasses critical environmental features such as the 100-year floodplain, steep slopes, and freshwater wetlands.

The City of Auburn ordinances and regulations require stream buffers on each side of perennial and intermittent streams. Buffers are comprised of three zones: Streamside Zone, Managed Use Zone, and Upland Zone. The total width of these zones ranges from 35 feet to 100 feet, depending on the size of the draining watershed.

Figure 13: Example of rainwater being harvested and used in conjunction with a bioretention area and pervious concrete.

***Areas of Opportunity**: For additional promotion of stream and floodplain preservation and function, the minimum buffer width could be increased to 50 feet (or more). The existing stream buffer preservation requirements also do not appear to include adjacent wetlands, steep slopes, or the 100-year floodplain. Nor do they appear to require greater buffer widths for sensitive resources (e.g., designated high quality streams) or in certain zones (e.g., drinking water protection). Enhancements in these areas are also recommended.*

Buffer Management

Principle: The riparian stream buffer should be preserved or restored with native vegetation that can be maintained throughout the plan review, delineation, construction, and occupancy stages of development.

City codes prohibit the removal of live vegetation and allow for the removal and control of exotic species in an attempt to restore native vegetation to the streamside buffer zone.

Prohibited uses and permitted land uses and activities are adequately outlined in the documentation and enforcement, mitigation, and restoration mechanisms are detailed addressing violations.

***Areas of Opportunity**: The ordinance could be enhanced by requiring vegetation management to promote the restoration of native vegetative species and/or requiring that a minimum percentage of a buffer be maintained with native vegetation.*

Clearing and Grading

Principle: Clearing and grading of forests and native vegetation at a site should be limited to the minimum amount needed to build lots, allow access, and provide fire protection. A fixed portion of any community open space should be managed as protected green space in a consolidated manner.

Chapter 7 of the Auburn Code (Drainage and Flood Control) recognizes and states the potential negative impacts of unchecked clearing and grading operations. It specifically highlights the potential loss of native vegetation that is necessary for terrestrial and aquatic habitat. Other documents encourage the minimization of clearing and require that clearing be in accordance with the Alabama Handbook for Erosion and Sediment Control and Stormwater Management on Construction Sites.

The limits of disturbance are also required to be shown on construction plans and physically marked at the site. However, there doesn't appear to be specific penalties for the violation of the general requirements associated with clearing and grading. Incentives for restoring native vegetation and forests once removed were also not found.

Staff has stated that the tendency for development to utilize mass clearing and grading has increased over the past decade. With this continuing trend, the importance of preserving native soils, hydric soils, natural vegetation, and steep slopes at development sites is imperative.

***Areas of Opportunity**: The addition of clear and enforceable restrictions causing the delay and limitation of clearing should be considered.*

Tree Conservation

Principle: Conserve trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native plants. Wherever practical, manage community open space, street rights of way, parking lot islands, and other landscaped areas to promote natural vegetation.

A natural resources inventory showing the locations of all streams, lakes, 100-year floodplains, wetlands, wooded areas and other significant natural features on the site is required on the lot layout for conventional and conservation subdivision development submittals. A Site Analysis Map is also required delineating conservation areas serving as open space in conservation subdivision submittals. Specific information about individual or special existing trees does not appear to be required.

Grand Trees (those whose diameter is 32 inches or greater at breast height, or whose circumference is greater than 100 inches at four and a half feet above ground level) shall be preserved whenever possible whether they are on public or private property, per the design standards.

With exception of requirements for vegetation in parking lot islands which may include trees, and the allowances for greenspaces which may also include trees, there were no apparent requirements for tree planting or for the establishment of forests in areas where none exist.

Codes provide limitations on tree planting near streets and prohibit canopy tree planting within ten feet of certain utilities and in easements without prior approval from the City of Auburn. It appears that trees and native plants are permissible for landscaping in yards, common areas, and other open spaces.

Policies and procedures for carrying out the provisions of the Municipal Tree Ordinance are set out in The Municipal Tree Ordinance Implementation Guidelines. A copy of these guidelines is required to be on file with the City official and available to all City departments. The guidelines were not readily available to the public via the internet. Language outlining the details of tree protection during development was not found in available documentation.

***Areas of Opportunity**: Recommendations related to tree conservation would initially include a requirement that certain types and sizes of trees be included in the required natural resources inventory. Also, tree conservation requirements should identify or reference methods for delineating and protecting the critical root zone of trees (sometimes referred to as "drip line"), if not included in the implementation guidelines already. It is recommended that landscaping requirements also identify or reference specifications for soil amendments, planting methods, species selection, and maintenance.*

Land Conservation Incentives

Principle: Incentives and flexibility in the form of density compensation, buffer averaging, property tax reduction, stormwater credits, and by right open-space development should be encouraged to promote conservation of stream buffers, forests, meadows, and other areas of environmental value. In addition, off-site mitigation consistent with locally adopted watershed plans should be encouraged.

Development incentives are provided to developers of qualified planned development if requested in exchange for a public benefit or amenity. Relevant available incentives include: density bonuses; increased floor area ratios; reduced setbacks; reduced minimum lot widths; accelerated preliminary plat approval process; and increased impervious surface ratios. Possible exchanges for these incentives include: open space improvements; housing for the elderly and low and moderate-income families; vegetated buffer along the perimeter; increased open space; park and recreation areas; parking in rear for multifamily housing or commercial/office use; limited access; low density along the perimeter of the development; and open space to the City of Auburn.

***Areas of Opportunity**: Other stormwater-related credits could also be included to enhance the City of Auburn's protection of its waters and watersheds. Flexibility to meet land conservation requirements appears to be intended but could be enhanced through offering additional mechanisms such as: density compensation and transfers; buffer or lot averaging; by-right open space development; transferable development rights; and off-site mitigation.*

Stormwater Outfalls

Principle: New stormwater outfalls should not discharge unmanaged stormwater into jurisdictional wetlands, sole source aquifers, or other water bodies.

City codes include special protections and limitations for impaired streams and for certain watersheds. They also restrict development within the 100-year floodplain and protect wetlands and other waters.

The codes are limited on the allowance and promotion of acceptable uses of rainwater and corresponding treatment requirements. The codes also tend to place priority on peak runoff rate management over post-construction runoff volume reduction.

The Public Works Design and Construction Manual requires that there be no increases in peak discharges or runoff volumes when comparing predevelopment to post development hydrologic conditions (mainly looking at impacts to existing system/infrastructure). The Water Resources Design and Construction Manual provides an emphasis on water quality management and also contains a comprehensive catalog of post-construction runoff management practices and highlights the ability of many to reduce runoff volumes.

However, the DRT subdivision development submittal checklists references the City of Auburn's requirements for runoff volume management. The Water Resources Manual requires "treatment" of the Water Quality Volume (defined as runoff from the first 1.2" of rainfall), but not volume mimicry or complete retention of this volume.

There are code requirements for detention ponds and their being subject to annual inspections by the City of Auburn and the owner being responsible for maintenance. The term, stormwater storage facility, is used in other documents where operations and maintenance requirements are described.

The existing Erosion and Sediment Control Ordinance appears to be in line with the state-of-practice for construction stormwater management otherwise.

> ***Areas of Opportunity****: Recommendations for ordinance enhancement in this area include a greater emphasis on minimizing or eliminating hydrologic increases in runoff volume caused by development. The inclusion of language in City codes that address all permanent stormwater management features (not just detention ponds or practices that "store" runoff) is also recommended. Incentives for consideration of runoff reduction concepts early in the planning process are also advised.*
>
> *In addition to the above recommendations for post-construction stormwater management, the construction-related guidance could be enhanced in the area of protection of post-construction BMPs and other green infrastructure during construction.*

Process and Administrative Opportunities

It is recommended that the City of Auburn be involved with developers earlier in the design process so that there is an opportunity to educate developers on stormwater requirements and encourage them to incorporate GI/LID into site design. This could be done by providing education, resources, and example cost-breakdowns to promote GI/LID options before design is finalized.

According to the City of Auburn's current process, developers have usually already decided on the site layout and completed conventional stormwater design before applying for an application from the Water Resources Department. Changing an existing design to include GI/LID is often too costly or time-consuming to be practical. Development of a Stormwater Fact Sheet outlining the multiple benefits to GI/LID to distribute to developers early in the plan review process could help achieve these goals. The Fact Sheet should summarize stormwater management options, resources for including GI/LID, and the information and incentive for participating in a Pre-Planning Meeting. Based on the questionnaires, City staff would like to see cost breakdowns shared with developers to encourage GI/LID and promote it as cost effective.

In addition to earlier coordination in stormwater design, the City of Auburn would also like to see more Urban Forester involvement in site plan review to promote tree preservation, maintenance, and planting. Developers should be encouraged to view the Urban Forester as an important resource to protect trees, which improve land value and aesthetics, and to keep them in compliance with the City of Auburn's requirements on altering trees on public property and within stream buffers.

A Pre-Planning Meeting can be a valuable planning exercise which examines the existing hydrologic and natural resource characterization of a property that is being considered for new development or redevelopment. The overarching goals of the process are to identify: 1) opportunities for the use GI/LID site design approaches; 2) potential limitations for the use of GI/LID practices; and 3) potential GI/LID incentives that can be offered. Ideally, early identification of these items will save the developer time and money.

The Pre-Planning process can consist of a Report and Meeting. The Report is a collection of available data for hydrologic, historic and other conditions that can influence stormwater management on the property. Report preparation is followed by a meeting between the City of Auburn's stormwater staff and the property developer where site conditions and LID/GI opportunities and limitations are evaluated. Depending on the project location and scope, input from the Urban Forester may also be valuable.

To be effective, the Pre-Design Meeting must occur very early in the site planning process before the creation of the layout of buildings and pavement and the demolition and/or grading plan. Establishment of the Pre-Planning Meeting should be integrated into the stormwater review process. The basic requirements, policies and process should be drafted with City staff input, and then put forward to members of the development community for their input and buy-in. The final process should be documented in the Post-Construction Stormwater requirements.

Table 4. GI/LID Road Map

Ordinance	Proposed Revision	Promotes Goals to: Avoid/Minimize/Mitigate Stormwater Impacts	City Priority to Change (1-High, 2-Medium, 3-Low)	Easy/Medium/Hard to Change
Drainage and Flood Control, Chapter 7, Sec. 7-108 - BMP plan	More clearly define “industrial facilities” and “high risk facilities” so that BMPs requirements can be better identified and implemented. Consider a “hot spot” definition and reference BMPs in supplemental documents.	Minimize	3	Easy
Planning and Development, Chapter 17, Section 17-66 - Replacement of trees and planting of new trees on or near public property	The City of Auburn specifies the species, planting time and planting location of all replacement trees. A requirement for native trees and a reduction of soil compaction during planting could be added.	Mitigate	2	Medium
Chapter 21, Streets and Sidewalks, Sec. 21-46 - Paving	Paving surface is defined here. Revise ordinance to allow pervious pavement. Per the Auburn Water Resource Management Design and Construction Manual, Pervious Pavement is permitted in low traffic areas.	Mitigate	2	Easy/Medium
Chapter 15 Nuisances, Sec. 15-16 - Prohibited nuisances declared	Revise weed ordinance to exclude rain gardens and other vegetated BMPs from 12 inch height requirement, etc.	Minimize and Mitigate	3	Easy
Zoning Ordinance, 422.04 - Off-street parking landscaping requirements	Only landscape islands/peninsulas greater than 304 square feet and 9 feet wide count toward parking lot landscape requirements. Include smaller bioretention areas and urban bioretention areas to create more incentive for their construction.	Minimize and Mitigate	2/1	Med/Hard
Chapter 21 of the Code of Ordinances	Reduce the area of impervious cover associated with subdivision development by reducing the minimum pavement widths stated in the Chapter 21 of the Auburn Code of Ordinances from 27 feet to 22 feet and encourage permeable on-street parking lanes with bioretention provided in the extended curb areas by highlighting these opportunities in City guidance and subdivision review processes and checklists.	Avoid and Minimize	1	Med/Hard
Chapter 21 of the Code of Ordinances	City development and guidance could further highlight the desire to reduce impervious cover by also addressing street length. Reduce total length of residential streets by examining alternative street layouts to determine the best option for increasing the number of homes per unit length. Adopting a development approach such as Traditional Neighborhood Development and incentivizing implementation where appropriate is recommended. City should allow reduced street width and should seek to encourage design speeds match posted speeds based upon local street classification.	Avoid and Minimize	3	Med/Hard
Chapter 21 of the Code of Ordinances	Change the minimum right-of-way width for residential streets from 50 to 45 feet to promote minimized clearing during development and maximizing long-term land use. Where appropriate, allow additional utilities beneath the roadway to produce a more compact development footprint.	Avoid and Minimize	2/3	Med/Hard
Chapter 21 of the Code of Ordinances	Promote a reduction in cul-de-sacs, allow landscaped islands to be used as stormwater management features, and grant open space credits to maximize the use of this vegetated space.	Avoid and Minimize	3	Hard
Subdivision Ordinance	Modify codes to bring attention to the potential for vegetated swales being utilized for stormwater management in accordance with technical guidance given in the design manuals.	Mitigate	2/1	Easy/Med
Zoning Ordinance	Set minimum and maximum numbers of parking spaces allowed. A study of the source and of the requirements should be considered to ensure the appropriateness and applicability of the prescribed limits. The Institute of Traffic Engineers, the Urban Land Institute, and the National Parking association provide industry standards that can be adjusted to reflect local characteristics. The City of Auburn measures parking stall length from the edge of gutter as opposed to the back of curb. This would reduce impervious surface if existing dimensions were applied differently. Consider revising or clarifying.	Minimize	2/1	Med/Hard
Zoning Ordinance	Enhance current parking reduction incentives (no off-street parking requirement in urban core, no more than 50% of urban core property in the urban core can be utilized for drives and parking [with exception of parking garages]) by requiring consideration of transit oriented development and shared parking. The current language and City approach may be appropriate for the City of Auburn’s current size and density. However, in urban areas, incentives for structured parking should remain an option to decrease the overall costs to developers, and for the social, economic, and environmental benefits to the City of Auburn.	Avoid	1/2	Med/Hard

Ordinance	Proposed Revision	Promotes Goals to: Avoid/Minimize/Mitigate Stormwater Impacts	City Priority to Change (1-High, 2-Medium, 3-Low)	Easy/Medium/Hard to Change
Department of Public Works Construction and Design Manual	The codes could be more specific in their endorsement of flush curbs, curb cuts, and depressed landscaped areas for direction of runoff into vegetated landscaped islands or other runoff reduction practices. Also, the current greenspace dimensions shown on the Standard Details for streets should be brought into alignment with other minimum dimensions for these areas. The Standard Details currently show a dimension of 5'-10'.	Minimize and Mitigate	1	Easy/Med
Conservation Subdivision Ordinance	The Conservation Subdivision concept should be publicly endorsed and promoted by the City of Auburn at every opportunity. The regulations should be offered as a first option and be given priority in submittal and review processes. Also, to be more encouraging of open space design, the regulations could be clarified to require 50% of the buildable portion of the site. A reduction in impervious area should be listed as one of the purposes and goals of the conservation subdivision.	Avoid, Minimize and Mitigate	1/2	Easy
Zoning Ordinance	Consider relaxing minimum road frontages to allow for potential decreases in the lengths of streets, driveways, and sidewalks, resulting in an overall reduction in total site imperviousness.	Minimize	3	Med/Hard
Auburn Design Standards	An official Complete Streets policy could help to balance the needs for mobility and a reduction of imperviousness associated with pedestrian and bicycle facilities.	Avoid	1	Hard
Driveway Details	The impervious area of lots could be further minimized by reducing the currently required minimum driveway width of ten feet to nine feet. Also, the use of alternate materials such as pervious pavements, and alternative configurations such as two-track, should be considered for inclusion in codes as being allowed where appropriate.	Minimize	2	Easy/Med
Subdivision Ordinance	Enhance open space requirements by including standards that require interconnections, prioritized lists of resources to be conserved, and access standards.	Avoid	3	Med/Hard
Stream Buffer Ordinance	For additional promotion of stream and floodplain preservation and function, the minimum buffer width could be increased to 50 feet (or more). The existing stream buffer preservation requirements also do not appear to include adjacent wetlands, steep slopes, or the 100-year floodplain. Nor do they appear to require greater buffer widths for sensitive resources (e.g., designated high quality streams) or in certain zones (e.g., drinking water protection). Enhancements in these areas are also recommended.	Avoid	3	Med/Hard
Stream Buffer Ordinance	The ordinance could be enhanced by requiring vegetation management to promote the restoration of native vegetative species and/or requiring that a minimum percentage of a buffer be maintained with native vegetation.	Mitigate	3	Hard
Chapter 7 of the Auburn Code (Drainage and Flood Control)	There doesn't appear to be specific penalties for the violation of the general requirements associated with clearing and grading. Incentives for restoring native vegetation and forests once removed were also not found. The addition of clear and enforceable restrictions causing the delay and limitation of clearing should be considered.	Minimize and Mitigate	2/3	Hard

Ordinance	Proposed Revision	Promotes Goals to: Avoid/Minimize/Mitigate Stormwater Impacts	City Priority to Change (1-High, 2-Medium, 3-Low)	Easy/Medium/Hard to Change
Municipal Tree Ordinance	Recommendations related to tree conservation would initially include a requirement that certain types and sizes of trees be included in the required natural resources inventory. Also, tree conservation requirements should identify or reference methods for delineating and protecting the critical root zone of trees (sometimes referred to as “drip line”), if not included in the implementation guidelines already. It is recommended that landscaping requirements also identify or reference specifications for soil amendments, planting methods, species selection, and maintenance.	Minimize and Mitigate	1	Med/Hard
Stormwater Ordinance and Guidance	Recommendations for ordinance enhancement in this area include a greater emphasis on minimizing or eliminating hydrologic increases in runoff volume caused by development. The inclusion of language in City codes that address all permanent stormwater management features (not just detention ponds or practices that “store” runoff) is also recommended. Incentives for consideration of runoff reduction concepts early in the planning process are also advised. In addition to the above recommendations for post-construction stormwater management, the construction-related guidance could be enhanced in the area of protection of post-construction BMPs and other green infrastructure during construction.	Minimize	1	Med/Hard
Document				
Stormwater Handout for Developers	Develop a Stormwater Handout for the city to give out to potential developers so that they are given the information early in the planning process and informed about stormwater management options, including GI, and the incentive for a Pre-Planning Meeting.	Avoid, Minimize, and Mitigate	1	Easy
Department of Public Works Construction and Design Manual	To further reduce the potential impervious area, the City of Auburn should consider including a fixed proportion (e.g.,15%) of parking spaces at larger commercial parking lots with smaller dimensions for compact cars. Also, in addition to highlighting where pervious pavements should not be used, codes and regulations could be enhanced by promoting the use of pervious pavements of appropriate materials for appropriate applications.	Avoid, Minimize, and Mitigate	2/1	Med/Hard
Development Review Team (DRT) Processes, Submittal Requirements, or Checklists	Revise DRT submittal processes and checklists to reflect updated GI/LID practices.	Avoid, Minimize, and Mitigate	1	Easy
AL LID Manual and City Stormwater Specifications	Additional specification and details should be added to assist developers in designing and implementing GI/LID BMPs and other BMPs. The developed materials should be reflective of the character and style the City of Auburn wishes to maintain, particularly in the urban core.	Avoid, Minimize, and Mitigate	1	Med/Hard
Water Resource Management Design and Construction Manual	The manual and other documents could be enhanced in the area of rooftop runoff management with the specifically stated allowance of temporary storage of rainwater in storage tanks (e.g., rain barrels or cisterns). Local building and plumbing codes could also allow and provide guidance for the use of harvested rainwater for exterior uses such as irrigation and non-potable interior uses such as toilet flushing. Other enhancements could include guidance for and the regulation of the use of green roofs.	Mitigate	2	Med/Hard
Auburn Water Resource Management Design and Construction Manual	Buffers are required around perennial and intermittent streams, with required widths defined by drainage area. Wetlands have a 25-foot buffer with an additional 15 feet to structures. As recommended above, using a larger buffer is recommended. The wetland buffer language should more strongly encourage addressing compacted soils.	Avoid	3/2	Med/Hard
GI/LID Incentive				
Construction Pre-Planning Meeting	Incentivize a Pre-Planning meeting to assist developers with incorporating GI/LID earlier in the design process.	Avoid, Minimize, and Mitigate	1	Medium
Stormwater Credits	Other stormwater-related credits could also be included to enhance the City of Auburn’s protection of its waters and watersheds. Flexibility to meet land conservation requires appears to be intended but could be enhanced through offering additional mechanisms such as: density compensation and transfers; buffer or lot averaging; by-right open space development; transferable development rights; and off-site mitigation.	Avoid, Minimize, and Mitigate	2	Med/Hard

Selection of Pilot Green Infrastructure Projects

As a means of exemplifying the City's vision and providing a path to the implementation of the Guidance Document, the City intends to implement ten Pilot Green Infrastructure Projects through the incorporation of green infrastructure (GI) Best Management Practices (BMPs) into currently planned City projects.

A master list of potential projects was developed through the compilation of available GIS data, review of planning documents including the Streetscape Master Plan, Parks, Recreation and Culture Master Plan (PRCMP) Draft, Parks & Recreation Proposed Project from PRCMP Recommendations list and related documents, along with input from City staff. Project sites were selected to showcase a range of proven GI BMPs. As such, these sites may not correspond with the highest priority CIP sites in the City. Sites are located within the right-of way, and on publicly owned parcels allowing the City to lead by example in the implementation of GI in Auburn.

Table 5: Selected Pilot Green Infrastructure Projects

Project ID	Project Name
2	MLK Streetscape Master Planning
13	Town Creek Park
15	Boykin/Donahue Campus
16	Dean Road Recreation Center
19	Felton Little Park
21	Lake Wilmore Park
24	Parks and Recreation Main Campus
26	Sam Harris Park/Shug Jordan Soccer Fields
31	COA Library: renovation and outside improvements
32	East & West Magnolia/Tichenor Ave improvements

A spatial review and analysis were performed to identify preferred opportunities to incorporate green infrastructure (GI) practices into current and/or planned municipal capital improvement projects, resulting in a refined list of ten potential projects.

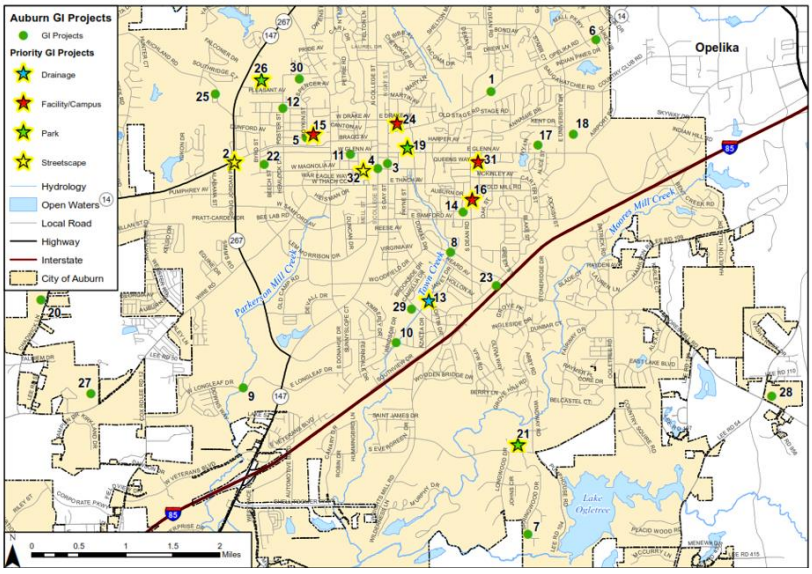


Figure 14: Green Infrastructure Pilot Project Locations

The concept plans for ten GI project sites and associated GI practices were developed and sized for the identified 2-year, 24-hour design storm. This storm exceeds the typical water quality based volumetric design often used for sizing green infrastructure BMPs.

GI BMPs utilized in the conceptual design are detailed in the concept plans, and include:

Stormwater Swales: provide filtering, conveyance, surface and subsurface storage and infiltration within stone base and underdrain; can have varied surface treatments including decorative rock, turf grass, or bioretention plantings.

Permeable Pavement: including permeable pavers, Porous Pave, and PaveDrain to replace traditional parking pavement, or used in roadway shoulders and greenway paths. Generally combined with subsurface storage and infiltration cells.

Bioretention / Bioswale: provide filtering, surface and subsurface storage and infiltration within stone base. Can be varied configurations and can be interconnected with other BMPs for a treatment train.

Downspout Planters: Pre-manufactured planters are decorative and handle a larger volume of runoff than rain barrels. They can be used as part of building landscape and planted with decorative annuals or used for herb or vegetable gardens.

Figure 15: Legend showing Pilot Project symbols

Subsurface Storage: Often used in conjunction with surface BMPs. Can consist of a washed stone gallery or any number of premanufactured vault or tank type systems.

In addition, level spreaders are used for energy dissipation and to disperse concentrated flows from impervious areas into BMPs, and sidewalk trench grates and other typical storm appurtenances are used for shallow conveyance to BMPs.

Concept BMP sizing was completed through desktop analysis and modelling of parameters including contributing watershed, proposed impervious area to be managed, calculated runoff coefficients, and runoff volume management.

The concept plans include:

- Narratives of the proposed green infrastructure (GI) practices including general location and size, and recommendations for long-term operations and maintenance;
- Project location maps and concept plan graphics including location, size and connectivity;
- Example graphics and photographs of proposed GI practices in similar applications;
- Preliminary engineering calculations for sizing the GI practices and the resultant performance objectives;
- Typical design details and cross sections; and
- Concept-level opinions of construction cost and estimate of long-term maintenance costs.

GI BMP Calculation Methods and Assumptions

GI BMPs were sized individually for each site using the methods outlined.

Contributing Watershed

The areas of each site with proposed impervious cover and GI installations were delineated in GIS using the proposed site plan drawings along with GIS elevation data and aerial photography. Contributing drainage areas were drawn based on the assumption that runoff from upgradient areas would be diverted around the proposed impervious areas wherever possible, and not drain to proposed GI installations. For this stage of the project the contributing drainage areas were not subdivided for each individual GI practice but were considered as larger systems treating areas of the site with contiguous areas of impervious cover and multiple GI practices. Some sites were considered as one contributing watershed and others were split up into multiple contributing watersheds in areas where different parts of the proposed development on site are not hydraulically connected and the GI systems will work independently.

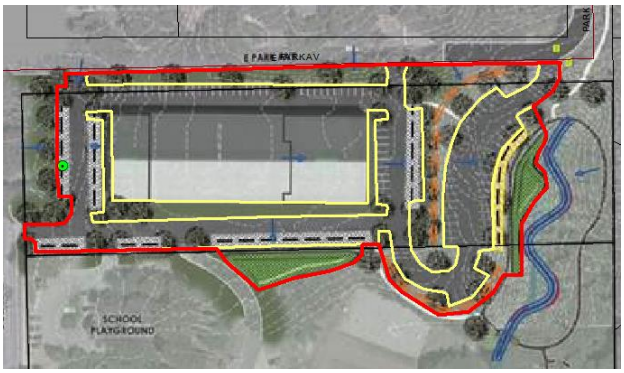


Figure 16: Dean Road Rec Center Example Contributing Watershed

Impervious Area Managed

The impervious areas within the contributing watersheds were drawn in GIS based on the existing aerial photography and the proposed development plans for sites. Narrow sidewalks that will discharge runoff into adjacent pervious areas were not counted as impervious cover. Proposed permeable pavement areas were counted as impervious area because they will be receiving rainfall and contributing to the total amount of runoff to be managed, even though the rainfall will be primarily infiltrating directly into the underground storage layers of the permeable paver GI practices.

Design Storm

The design storm is the 2-year, 24-hour event. A rainfall depth for this event in Auburn of 4.16 inches was generated by the NOAA Precipitation Frequency Data Server online application, based on data in the NOAA Atlas 14, Volume 9, Version 2.

Volumetric Runoff Coefficient

The SCS Curve Number method was used to determine runoff volumes for the design storm, so a composite curve number was calculated for each contributing area based on the calculated impervious cover percentage and other land use and soil type.

Projected Runoff Volume Management (Storage and Infiltration)

For this preliminary pilot project, storage volumes for each type of GI practice were estimated using assumed depths of storage layers, GI sizes, storage layer void percentages, and other factors. The total capture volume of the combined GI systems for each contributing watershed was calculated. It has been assumed that captured runoff in the GI systems will be infiltrated into the native soil under and around the individual GI practices based on the favorable soil types shown in the area in the NRCS Web Soil Survey, but further investigation of soils, water table, depth to bedrock, and other geologic factors could change this assumption. For preliminary analysis and costing, adequate volume to handle the entire storm event was provided, without consideration for infiltration occurring during the storm. Further modelling on a site-by-

site basis during design can lead to a refined sizing of BMPs that can help to reduce volume and associated costs by considering infiltration occurring during the storm event.

For the concept level designs, typical BMP cross section assumptions were made, and applied to the draft plans to evaluate compliance with the design volume requirement. Plan sections were adjusted on a site-by-site basis if needed to achieve compliance. Typical BMP sections are shown in **Figure 17**.

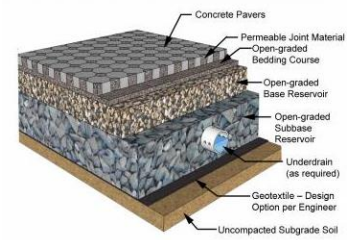
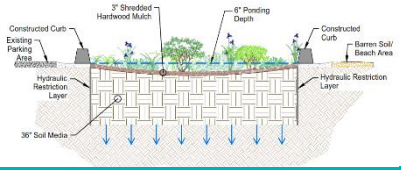
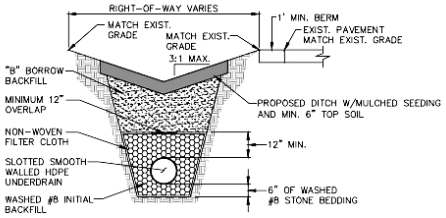
Permeable pavement: 4" stone paver base over 10" structural stone base and 2' subsurface stone storage with underdrain (increased to a maximum of 3' in areas necessary to meet volume)	
Bioretention: 8" to 12" of short term surface ponding with 12" to 24" of soil over 12" of washed stone and underdrain	
Infiltration swale – 4' depth with underdrain bedded in 12" – 24" of washed stone	

Figure 17: Typical BMP sections

Preliminary Estimate of GI Construction Cost

Uncontrolled or poorly managed stormwater runoff can threaten public health and aquatic life, negatively affect recreational activities, reduce the service life of existing roadway infrastructure, increase water treatment demands, contribute to flooding events, and cause erosion of valuable land. This costs the City money in the form of property damage, increased road, bridge and facility maintenance demands, erosion, and water quality treatment expenses.

In order to mitigate these impacts, use of Low Impact Development (LID) and GI design strategies, integrating stormwater management into site elements is a desirable alternative solution. GI site design replaces at least some portion of traditional stormwater collection curb and gutter, piping, inlets, and manhole structures and distributes appropriate GI BMPs such as bioretention, infiltration trenches, bioswales, permeable pavement, stormwater planters, subsurface infiltration, and rainwater harvesting/cisterns, into the site landscape and infrastructure and interconnects them to address the required runoff management. GI Practices can cost less to install and maintain than traditional stormwater practices and they can provide multiple aesthetic, health and economic benefits. For example, cisterns can reduce the need for irrigation and even potable water. Native drought-tolerant plants can also eliminate the use of potable water and fertilizers.

For the ten pilot projects presented, GI BMP costs were developed to support the concept plans. Unit prices were assigned using a combination of regional bid tabs, national GI pricing databases, and data from prior projects completed by Wood.

The preliminary cost estimates provided represent the anticipated conceptual cost of incorporating GI BMPs into a proposed full-scope improvement project in lieu of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered part of the base project and as such are not included. Base project estimated costs for elements to be replaced with GI BMPs such as pavement, stormwater collection infrastructure, curb and gutter, detention, ditches, etc. can be evaluated and deducted as project planning and design progresses.

Because of the conceptual nature of the master plans used as the basis for the GI concepts and pricing, a 20% contingency was applied to the projects. (25% was used for the MLK project due to coordination with ALDOT.) Engineering Design and Construction Management activities were estimated at 25% of the GI cost.

For preliminary analysis and costing, adequate volume to handle the entire storm event was provided without consideration for infiltration occurring during the storm. Further modelling on a site-by-site basis during design can lead to a refined sizing of BMPs that can help to reduce volume and associated costs by considering infiltration occurring during the storm event.

Pilot Green Infrastructure Project Concept Plans

Concept design boards and cost estimates were prepared for each project. These are provided in **Appendix A**. **Table 6** outlines the compiled results, followed by a detailed narrative of each of the projects.

Table 6: Summary of Design Storm Runoff Volumes and Management

ID	Project Name	Project Type	Design Storm Drainage Requirement (Gallons)	Storage represented by concept plan and cost estimate	% of Design Storm control achieved	Projected Cost/SF managed	Notes
2	MLK Streetscape Master Planning	Streetscape	820,945	1,066,124	129.87%	$3.01	Can be refined to better match proposed grades during design.
13	Town Creek Park	Drainage	281,020	281,694	100.24%	$1.29	
15	Boykin/Donahue Campus	Facility/Campus	380,082	380,633	100.14%	$5.16	Cost includes rainwater harvest system for irrigation reuse.
16	Dean Road Recreation Center	Facility/Campus	233,408	235,089	100.72%	$3.34	Projected costs/sf managed does not include cost of creek channel restoration.
19	Felton Little Park	Park	231,362	227,040	98.13%	$4.71	Remainder of storage to be incorporated in proposed wetland conversion. Cost includes rainwater harvest system for irrigation reuse.
21	Lake Wilmore Park	Park	2,590,169	2,589,168	99.96%	$1.20	
24	Parks and Recreation Main Campus	Facility/Campus	431,619	433,523	100.44%	$1.51	
26	Sam Harris/Shug Jordan Soccer Fields	Park/Drainage	489,244	489,286	100.01%	$0.89	
31	Coa Library: renovation and outside improvements	Facility/Campus	78,267	67,968	86.84%	$1.80	Assume remainder of storage provided below PICP as planned in base project.
32	East & West Magnolia/Tichenor Ave. Improvements	Streetscape	327,161	239,484	73.20%	$7.27	Drainage catchment includes building and other surface areas outside of the ROW. If desired, these areas can be managed by deepening or expanding the subsurface storage.

GI Pilot #2 MLK Streetscape Master Planning

As part of a master plan, the City has been planning street improvements for the area bordered by Martin Luther King, Jr. Drive (MLK) and the railroad tracks between Shug Jordan Parkway and College Street to the south, Shug Jordan Parkway to the west and north, and the Cary Woods subdivision to the east. Enhanced landscaping, sidewalks, and improvements to attractiveness, walkability and vitality have been discussed as goals for this area by the City and members of the public.

For this pilot project, the master plan and City-developed recommended typical right-of-way section were used as a starting point. The pilot project adds the incorporation of GI BMPs into the right of way, but still meets the City's goals for the area. A stormwater collection/storage/conveyance system is proposed under walkways and under buffer areas between buildings and the road. The number of trees shown on the master plan was changed, and GI plantings were incorporated instead.

This pilot project serves as an example of a streetscape corridor GI practice. Along the corridor are fourteen stormwater planters which include stormwater storage or conveyance in their design. Standard curb and gutter are replaced with PaveDrain shoulders, which capture stormwater. Stormwater is stored and conveyed under the proposed sidewalks. Stormwater swales with grass or native plantings and a slotted underdrain are located along most of the corridor. To include more GI elements, sidewalks could be a pervious surface (PaveDrain, PorousPave or other). To save space and reduce costs, a portion of the 8-foot sidewalk and a 5-foot bike lane could be changed to a 10-foot marked multi-use path from Donahue to College. Plan views and details are included on the Pilot Project Boards in **Appendix A**.

The preliminary cost estimate for this project is **$1,445,421** and represents the anticipated cost of incorporating GI BMPs into the proposed project instead of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered part of the base project, whether GI is used or not. Where GI is used, the cost of traditional pavement, stormwater collection infrastructure, detention, ditches, etc. would not be incurred. Additional information about the cost of construction and maintenance are included on the Pilot Project Boards in **Appendix A**.

Figure 18: Example of a streetscape incorporating stormwater planter and sidewalk.

GI Pilot #13 Town Creek Park

Town Creek Park is a 70.2-acre park and includes a portion of Town Creek. The Town Creek Watershed Plan identifies this as an area that experiences problems with drainage and flooding. Town Creek is a waterway that has been experiencing excessive lateral migration and poor bank conditions and is in need of stream enhancement and restoration. There is also a Park Concept plan that calls for expanded trails, small shelters, improved landscaping, and additional playground equipment.

For this pilot project, GI elements were incorporated into elements addressing the need for park amenities and stream restoration. Four bioretention areas, two stormwater swales, and PaveDrain walkways that include trenches for stormwater collection have been incorporated into the park. Stormwater from PaveDrain walkways, parking areas and offsite drainage would enter bioretention stormwater and storage areas prior to discharging to a stormwater swale system. The swale system promotes infiltration with amended soils, drainage stone, and an underdrain. The swales also include check dams to slow down water and further promote infiltration. These BMPs serve to slow down peak flows and also improve stormwater quality. Natural channel restoration of Town Creek is proposed to both stabilize the creek and improve water quality. The restoration utilizes a combination of live staking and rock bank stabilization to naturally restore the creek while selective woody debris removal allows beneficial vegetation to grow and provide beneficial habitat. Plan views and details are included on the Pilot Project Boards in **Appendix A**.

This pilot project is an example of a City park GI project. GI elements are proposed for an existing City park that was already planned for renovation. This pilot project allows the park to provide stormwater management and address existing drainage problems. The proposed BMPs are low maintenance. Channel restoration is proposed to address overall water quality, erosion and flood management GI elements, such as the landscaping for the bioretention areas and the creek restoration both improve water quality and have aesthetic and ecological benefits for the park. Because this project includes 2,300 feet of stream restoration, there is the potential to obtain stream mitigation bank funding. Impacts to Town Creek may require permitting for Wetland and Waters of the US impacts.

The preliminary cost estimate for this project is **$818,937** and represents the anticipated cost of incorporating GI BMPs into the proposed project instead of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered part of the base project, whether GI is used or not. Where GI is used, the cost of traditional pavement, stormwater collection infrastructure, detention, ditches, etc. would not be incurred. Additional information about the cost of construction and maintenance are included on the Pilot Project Boards in **Appendix A**.

Figure 19: Example of sidewalk trench drain.

GI Pilot #15 Boykin/Donahue Campus

This pilot project is located on a community center campus property that includes a 10.6-acre site plus an adjacent 8.17-acre environmental services facility. Rain gardens, bioswales, and erosion control measures were put into place at the community center facility in 2009. The site currently includes a detention pond. The municipal parking lot is currently undergoing a gray/green design assessment and evaluation, a building expansion, additional parking, and a practice field are planned.

This pilot project proposes to meet the City's needs for expansion and additional amenities at the site while incorporating GI. The existing detention pond would be converted to an athletic practice field with subsurface storage, a greenway extension would be added, and educational elements would be incorporated. New parking bays would provide additional parking with permeable pavers and subsurface storage to intercept sheet runoff. Ten downspout planters will manage roof run-off and also overflow to the subsurface storage in the parking lot. Additional subsurface storage would be located beneath the new practice field, taking the place of the detention pond and making this area serve two purposes: stormwater management and recreation. The integrated subsurface stormwater storage under the parking lot and practice field allows the collected stormwater to then be reused for irrigation. Stormwater swales will border the parking lot to the east and south to provide additional conveyance and infiltration. A greenway trail constructed with PorousPave provides an additional amenity that incorporates GI. Plan views and details are included on the Pilot Project Boards in **Appendix A**.

This pilot project is an example of site-based 'Facility/Campus' GI Practices and provides multiple retrofit and improvement opportunities as well as educational opportunities. The location is highly visible to the community and can include educational opportunities, including interactive watershed exhibits. Additional amenities, such as a future outdoor classroom and recycling drop off will further increase the number of visitors.

The preliminary cost estimate for this project is **$857,537** and represents the anticipated cost of incorporating GI BMPs into the proposed project instead of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered part of the base project, whether GI is used or not. Where GI is used, the cost of traditional pavement, stormwater collection infrastructure, detention, ditches, etc. would not be incurred. After installation, costs for irrigation will be reduced as a result of the reuse system. Additional information about the cost of construction and maintenance are included on the Pilot Project Boards in **Appendix A**.

Figure 20: Example of a bioretention area incorporated into landscaping.

GI Pilot #16 Dean Road Recreation Center

The Dean Road Recreation Center is a 3.16-acre property located just north of Dean Road Elementary School. The City is proposing to add parking lots and pedestrian trails and expand the building, which would significantly increase the amount of impervious surface on the small site. In addition, offsite drainage enters the site from East Park Avenue and the residential neighborhood to the north and the site has steep slopes which can be an issue for stormwater runoff velocities.

For the design of this smaller scale pilot project, diverse GI BMP solutions and creek channel improvements are proposed to help meet the City's overarching goal of improved water quality. The additional parking needs would be met with permeable paver bays to intercept sheet flow runoff from the parking lot and also store the additional runoff that results from the building expansion. Level spreaders would slow the flow of runoff from the parking lot and spread it over a vegetated area prior to it entering a bioretention area upstream of the creek. Stormwater swales convey runoff around the parking areas while also promoting infiltration. Plan views and details are included on the Pilot Project Boards in **Appendix A**.

This pilot project also proposes to clean up the woodland area by removing dead vegetation and allowing new vegetation and habitat to flourish. Defining and lengthening the creek channel would promote water quality and habitat benefits. The creek channel improvements address water quality while making the creek safer, which is a concern due to the adjacent elementary school. Because this pilot project includes 400 feet of creek restoration, there is the potential to use the site for a stream mitigation bank. A formal stream mitigation banking program could allow for the creek restoration to be funded by off-site development mitigation needs.

This pilot project is an example of integrated site stormwater system retrofit GI practices. It would be an applicable example for other small public projects and also small commercial sites that may be planning an expansion or GI retrofit.

The preliminary cost estimate for this project is **$510,595** and represents the anticipated cost of incorporating GI BMPs into the proposed project instead of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered part of the base project, whether GI is used or not. Where GI is used, the cost of traditional pavement, stormwater collection infrastructure, detention, ditches, etc. would not be incurred. Additional information about the cost of construction and maintenance are included on the Pilot Project Boards in **Appendix A**.

Figure 21: Example of a parking lot draining to a level spreader and bioretention area.

GI Pilot #19 Felton Little Park

Felton Little Park is an 8.29-acre urban area softball and neighborhood park with large, existing detention basin at the headwaters of the upper Town Creek basin. The park is identified in the Downtown Master Plan as the best location for an outdoor entertainment venue and amphitheater. The $7.6M concept plan in the Downtown Master Plan would add impervious area by adding an entry plaza, parking lots, amphitheater, pavilion, greenway trail, and farmers' market structure.

This pilot project includes parking lot runoff interception, storage, infiltration and conveyance through permeable pavers, along with subsurface storage and water reuse. Sheet flow from the parking lot is intercepted by permeable paver parking bays, which are connected to subsurface storage. Four downspout planters are proposed to intercept downspout runoff and convey it to subsurface storage underneath multi-purpose athletic fields. Porous asphalt pathways would take the place of impervious surface needed for walkways. The subsurface storage would have a rainwater harvest and reuse system so that collected stormwater could be used for irrigation. A stormwater swale is included to intercept runoff from Opelika Road and filter it prior to diverting it to the proposed three-tiered wetland for treatment and detention. The wetland would replace the existing detention facility and would enhance both the water quality treatment and aesthetics of the site with its rock waterfalls. Plan views and details are included on the Pilot Project Boards in **Appendix A**.

The existing detention pond is located at the headwaters of the upper drainage basin for Town Creek and was not considered in the GI concept design for the facility because the stormwater storage requirements need to be coordinated with wetland runoff assumptions. The GI concept can be adjusted to provide or divert stormwater volume to the wetland to maintain the water level in the wetland.

The public location and anticipated public events would bring many people to Felton Little Park; therefore, it would be an excellent location for educational exhibits. Watershed education would be incorporated through the inclusion of an interactive watershed exhibit with public art pieces.

The preliminary cost estimate for this project is **$538,858** and represents the anticipated cost of incorporating GI BMPs into the proposed project instead of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered part of the base project, whether GI is used or not. Where GI is used, the cost of traditional pavement, stormwater collection infrastructure, detention, ditches, etc. would not be incurred. The cost estimate includes $100K allowance for irrigation/landscaping. Additional information about the cost of construction and maintenance are included on the Pilot Project Boards in **Appendix A**.

Figure 22: Example of public education signage.

GI Pilot #21 Lake Wilmore Park

Lake Wilmore Park is 208.38-acre parks facility located outside of the core metro area of Auburn. The Parks Master Plan proposes a $7.1M project to add multiple active and passive uses, including enhancing the existing recreation fields, ranges, and courses and adding nature trails. Because of building additions and additional parking, the Master Plan project would add impervious surface to the site.

This large-scale pilot project provides an opportunity for early planning and integration of GI BMPs to replace and offset costs of traditional stormwater management.

Additional parking is added in the form of permeable pavers, which promote infiltration and provide storage of stormwater. Stormwater swales along roadways and within the main parking area direct surface runoff from impervious surfaces while also promoting infiltration. Runoff to steeper slopes from the two smaller parking areas is slowed by level spreaders before entering bioretention areas. Eight bioretention areas would be added to the site to manage stormwater from impervious surfaces. The bioretention basins filter runoff from parking areas and provide storage with overflow to the creek. A premanufactured subsurface storage tank would be located beneath an athletic field to save space on the site and eliminate the need for a detention pond. It also provides a rainwater harvest and reuse system for irrigation. Plan views and details are included on the Pilot Project Boards in **Appendix A**.

The pilot project could also be expanded to include GI into extensions of Grove Hill Drive and Kentwood Drive roadways. The topography on the site required a more in-depth and complex analysis of proposed post construction drainage than would be typical at the early planning stage. It is likely that proposed BMP sizes and locations will require review and refinement once plans are further developed to ensure compliance with the designated design storm.

The preliminary cost estimate for this project is **$2,289,587** and represents the anticipated cost of incorporating GI BMPs into the proposed project instead of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered part of the base project, whether GI is used or not. Where GI is used, the cost of traditional pavement, stormwater collection infrastructure, detention, ditches, etc. would not be incurred. The preliminary cost estimate includes a $95,000 allowance for landscaping and irrigation and $125,000 for drainage and utilities. Post development, irrigation costs will be reduced as a result of the reuse system. Additional information about the cost of construction and maintenance is included on the Pilot Project Boards in **Appendix A**.

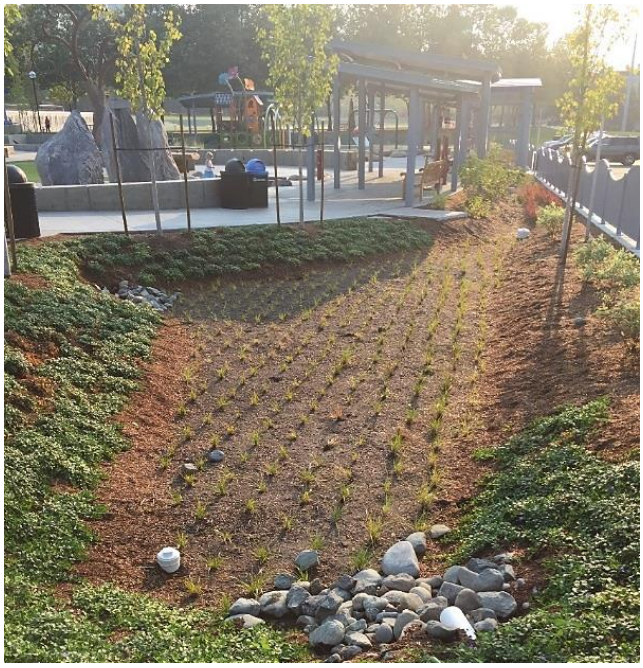


Figure 23: Example of bioretention area near playground and parking lot.

GI Pilot #24 Parks & Recreation Main Campus

The Parks & Recreation Main Campus is a 7.48-acre property that has a Master Plan Park Project. The existing parking, walkways, and landscaping are in good condition and the Master Plan proposes to extend the patio and parking, add courts and enlarge the building. The property is already highly impervious with some existing on-site stormwater management, including two detention ponds and large inlets providing surface detention storage on site. The Master Plan project proposes additional impervious area with minimal space for stormwater detention.

This pilot project includes parking lot runoff interception, storage, infiltration and conveyance through permeable pavers, along with subsurface storage. The existing detention pond on the west portion of the site would be converted to a bioretention facility to mitigate steep slopes, filter runoff from parking areas, and provide storage with overflow to storm system. A stormwater swale would intercept and convey runoff from the parking area and filter it prior to entering the bioretention basin. The smaller detention pond on the east portion of the site would be replaced with subsurface storage beneath a bocce ball court. Two downspout planters would intercept downspout runoff with subsurface overflows to the storm system. Impervious surface for additional parking would be reduced by using permeable pavers for the new spaces. Plan views and details are included on the Pilot Project Boards in **Appendix A**.

This pilot project is an example of a site with existing stormwater system retrofit with GI practices and it demonstrates how parking and site costs can offset proposed GI costs.

The preliminary cost estimate for this project is **$401,322** and represents the anticipated cost of incorporating GI BMPs into the proposed project instead of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered part of the base project, whether GI is used or not. Where GI is used, the cost of traditional pavement, stormwater collection infrastructure, detention, ditches, etc. would not be incurred. The base project cost estimate includes a $15,000 allowance for landscape and irrigation and $50,000 for overall staking, erosion control, site work and foundation grading. Additional information about the cost of construction and maintenance is included on the Pilot Project Boards in **Appendix A**.

Figure 24: Example of a downspout planter draining a roof leader.

GI Pilot #26 Sam Harris Park / Shug Jordan Soccer Fields

Sam Harris Park is a 30.14-acre park and the adjacent Shug Jordan Soccer Fields add an additional 19.81 acres. The unnamed tributary that bisects Sam Harris Park is part of a watershed that has been identified as impaired. The Master Plan for this site has a $300K per year budget for three years and includes a greenway and trail system, shelters, parking and drives. The Master Plan project would not add significant impervious area.

This pilot project provides an opportunity to mitigate water quality issues using GI to manage runoff. It also uses natural channel restoration to address overall water quality mitigation of TMDL issues in the watershed and addresses erosion and flood management.

Additional impervious surface added from the proposed shelters and pavilions and additional paved parking are managed with stormwater swales that promote infiltration and provide conveyance. Sheet flow from paved areas enters five bioretention areas. For the two portions of the site with steeper slopes, level spreaders are installed, for energy dissipation, upstream of the bioretention areas. Porous pavement would be used for the proposed greenway to connect with Shug Jordan soccer fields and Westview Park. Four downspout planters are proposed to collect runoff from the shelters and pavilions as part of the community garden. Plan views and details are included on the Pilot Project Boards in **Appendix A**. If the pilot project were to be expanded, a reuse system could be added to provide irrigation for the proposed community garden.

Because of impacts to waterways and a floodway, this pilot project would require floodplain permitting and wetland and waters of the US impacts and permitting would need to be taken into consideration

The preliminary cost estimate for this pilot project is **$1,353,198** and represents the anticipated cost of incorporating GI BMPs into the proposed project instead of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered part of the base project, whether GI is used or not. Where GI is used, the cost of traditional pavement, stormwater collection infrastructure, detention, ditches, etc. would not be incurred. The BMPs proposed are low maintenance bioretention and stormwater swales. Additional information about the cost of construction and maintenance is included on the Pilot Project Boards in **Appendix A**.

Figure 25: Example of a restored stream.

GI Pilot #31 Auburn Public Library

The existing Auburn Public Library has a parking lot and drives that are in very good condition and there is extensive manicured landscaping on the site. The parking lot's surface drainage pattern is conducive to the implementation of capture and treat practices. There is already a funded project to renovate the library and improve the library grounds with an outdoor learning center and a small amphitheater. The current concept plan incorporates sustainable design elements to enhance educational opportunities and support the City's stewardship of natural resources.

The Auburn Public Library pilot project is an example of Site Based 'Facility/Campus' GI Practices. It adds additional GI to the sustainable design elements in the concept plan by adding pervious parking bays, a bioretention area and a stormwater swale. The pilot project maintains existing parking counts and manages parking lot runoff with permeable pavement. The proposed permeable parking bays would have subsurface storage for stormwater. Curb turnouts would be installed in the parking lot to direct stormwater to GI BMPs. An existing parking lot inlet would be converted to a subsurface capture/overflow structure which ties into a new subsurface storage gallery below a proposed permeable paver plaza. North of the parking lot, a portion of the existing lawn would be converted to a bioretention facility with an underdrain connected to the subsurface storage. South of the parking lot, greenspace would be regraded into an infiltration swale.

Educational signage is proposed. Additional educational opportunities could also be added, since this is a site frequented by the public and it will have an outdoor learning center.

The preliminary cost estimate for this pilot project is **$67,233** and represents the anticipated cost of incorporating GI BMPs into the proposed project instead of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered part of the base project, whether GI is used or not. The base project budget is $1.65 million. Where GI is used, the cost of traditional pavement, stormwater collection infrastructure, detention, ditches, etc. would not be incurred. The BMPs proposed are low maintenance bioretention and stormwater swales. Additional information about the cost of construction and maintenance is included on the Pilot Project Boards in **Appendix A**.

Figure 26: Example of bioretention area with curb turnouts.

GI Pilot #32 East & West Magnolia / Tichenor Avenue Improvements

Streetscape improvements to Magnolia Avenue, between Wright Street and North Gay Street, and Tichenor Avenue, between North College Street and North Gay Street, are part of the continuing overall downtown street improvement master plan. The master plan already includes GI elements, such as permeable pavers and a rain garden.

This pilot project is located in a densely urban area with a high level of impervious surface and is an example of an urban streetscape retrofit. It includes roadway and parking runoff interception, storage, infiltration and conveyance through permeable pavers, along with subsurface storage. New, permeable pavement angled street parking would add 39,090 cubic feet of subsurface storage. The proposed walkways would include both a sidewalk zone for pedestrian use and a furniture zone with benches or other seating. The streetscape would be further enhanced with several stormwater planters. Thirty-six curb turnouts would also be used to direct runoff to the subsurface storage. To blend with and enhance the streetscape, tinted permeable pavers and decorative grating for subsurface storage are proposed. In addition to managing street and walkway runoff, this pilot project will likely include directly connected runoff from rooftops outside of the right-of-way.

The depth and configuration of underground storage can be varied to avoid utility conflicts once additional information is obtained. Tree planters could also provide additional or alternate storage option for stormwater.

The preliminary cost estimate for this pilot project is **$800,498.57** and represents the anticipated cost of incorporating GI BMPs into the proposed project instead of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered part of the base project, whether GI is used or not. Base project estimated costs for elements to be replaced with GI BMPs such as pavement, stormwater collection infrastructure, detention, ditches, etc. can be deducted. A base project budget was not available for review at the time this plan was developed. Additional information about the cost of construction and maintenance is included on the Pilot Project Boards in **Appendix A**.

Figure 27: Example of pervious parking area in a streetscape.

GI BMP CONCEPT DESIGN NEXT STEPS

As design progresses on each of the concept plans selected for incorporation of GI BMPs, the conceptual GI BMP layout, sizing, and modeling should be updated to reflect changes and progression of design plans. In many cases, a well-placed GI BMP layout can help to inform the overall design. In order to confirm the GI BMP sizing and costs presented here, the next steps are to:

- Review soils and water table information;
- Review existing site storm collection system routing, rim and inlet elevations; and
- Coordinate on the current layout, grading, impervious surface and stormwater collection routing.

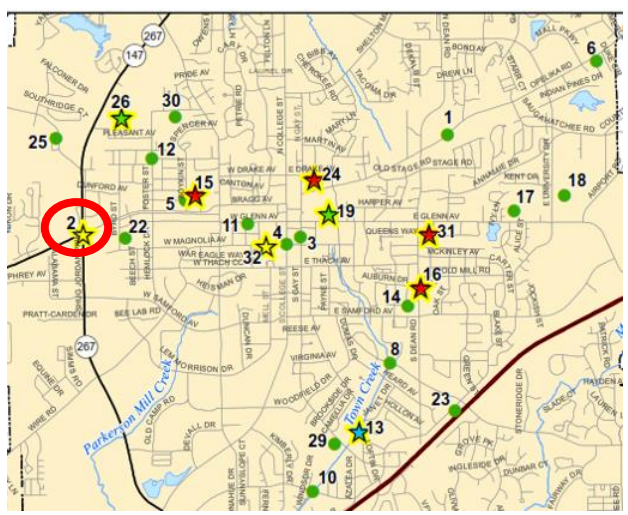
Appendix A
Green Infrastructure
Pilot Project Information Boards

GI Pilot #2 MLK Streetscape Plan

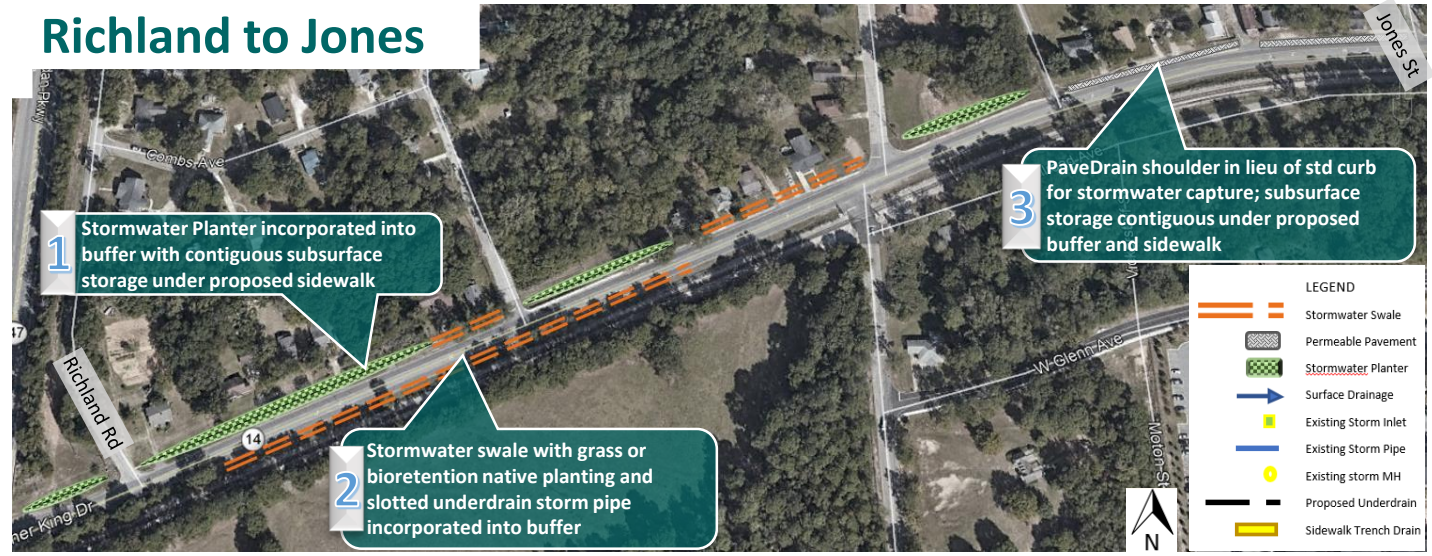
- Example for Streetscape Corridor GI Practices – Potential issue with practices in ALDOT ROW & adjacent to railroad ROW
- Several areas where it appears roadway drains toward houses on north side
- Adjust Conceptual Master Plan section to include use of integrated stormwater collection/storage/conveyance under walk & buffer
- Design Buffer using stormwater planters; stormwater swales (WM conflict on N. side)
- Potential for PaveDrain shoulders in lieu of standard curb & gutter section to integrate stormwater capture
- Potential for Permeable walk surface (PaveDrain ADA compliant, PorousPave or other)
- Adjust amount of trees shown on master plan in favor of GI plantings
- Concept plan alternative Donahue to College: 8' walk plus 5' bike lane could be 10' marked multi-use path to save space and costs

Site/BMP Characteristics	
Contributing Watershed	15.7 Acres
Impervious Area Managed	6.5 Acres
2-Year 24-Hour Design Storm	4.16 Inches
Volumetric Runoff Coefficient CN (Varies by developed sub-watershed)	72 - 91
Projected Runoff Volume	820,945 Gal
Preliminary Estimate of GI Construction Cost	$1,445,421
Engineering & Construction Management	$361,355
Estimated Annual Operation & Maintenance	$ 2,650
Cost per square foot managed (70% capture)	$ 3.01

Auburn Green Infrastructure Pilot Projects



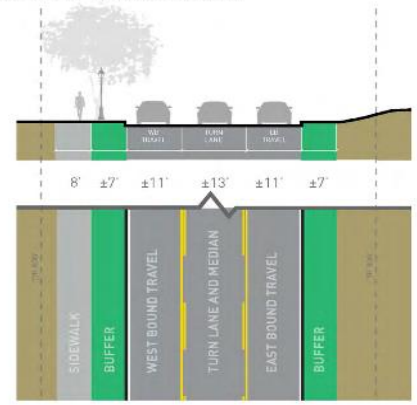
Richland to Jones



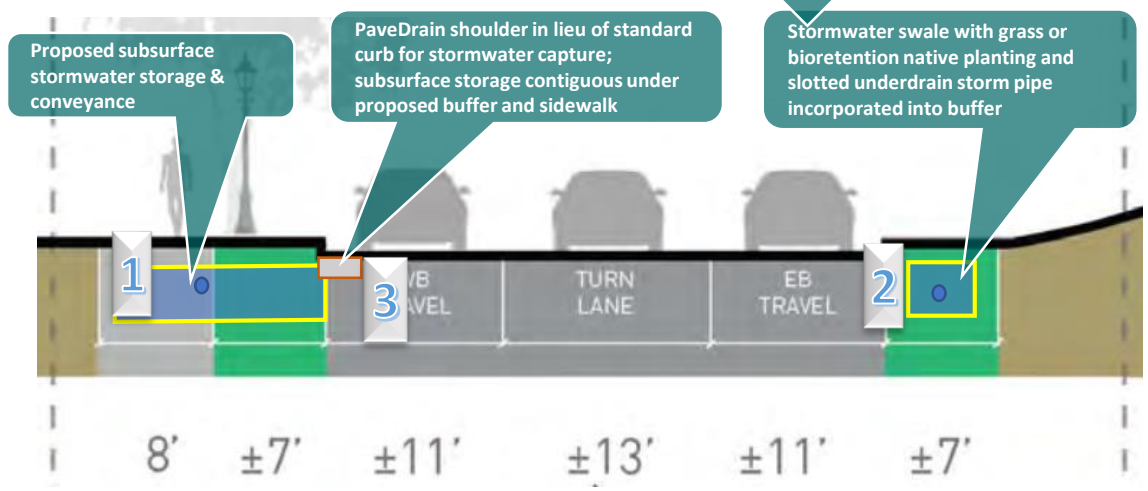
CORRIDOR DESIGN NOTES

Extracted from Auburn Streetscape Master Plan Dated 5/29/2018

PROPOSED TYPICAL SECTION

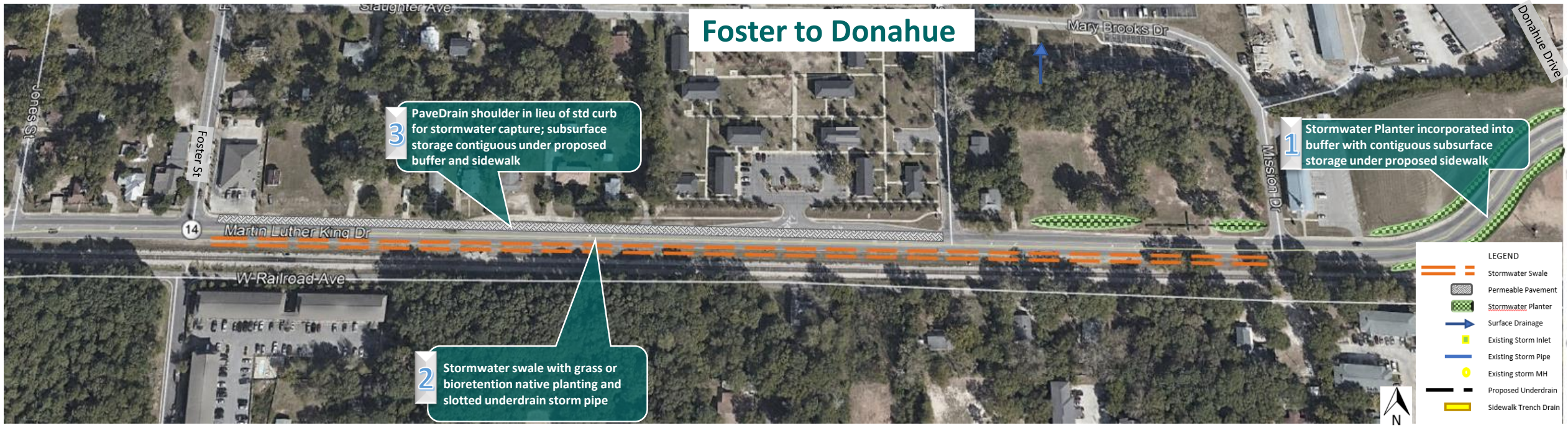


Recommended sidewalk width: 8' (min. 5' if severely constrained)
Recommended typ. buffer width: 7' (min. 5')
Buffer may be larger depending on space available from edge of travel lane

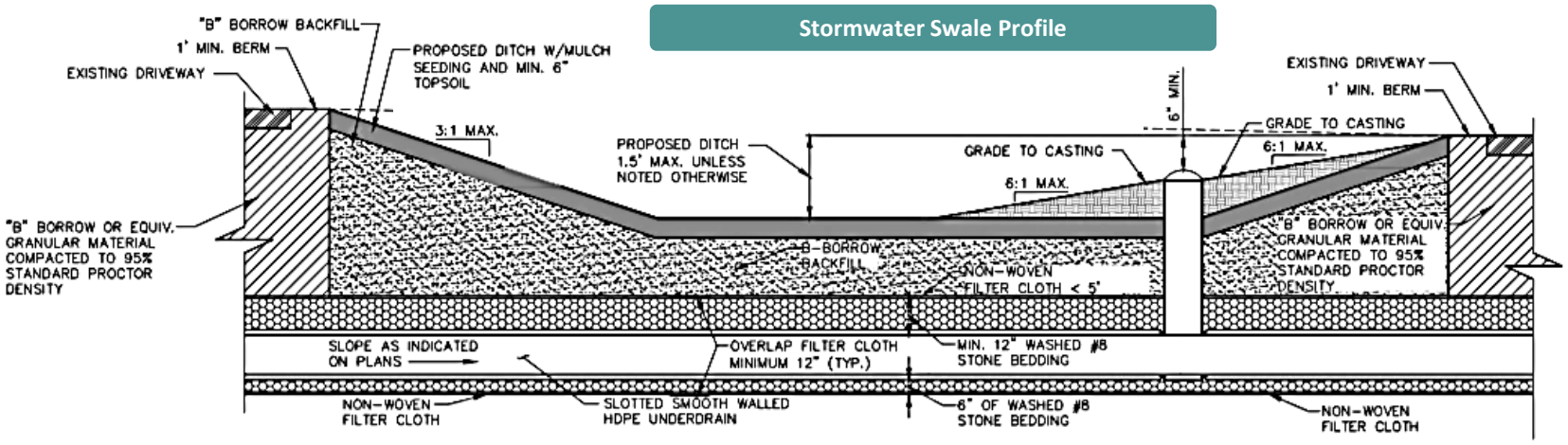


City of Auburn

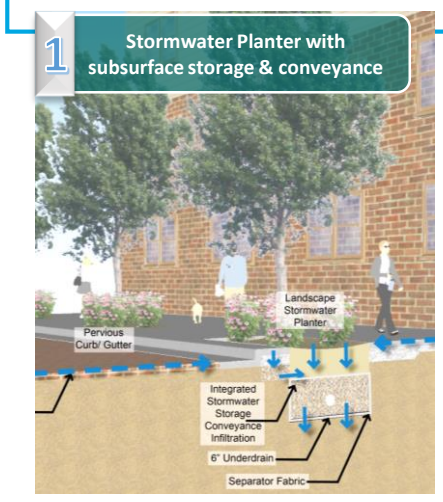
GI Pilot #2 MLK Streetscape Plan



Stormwater Swale Profile



1 Stormwater Planter with subsurface storage & conveyance



1 Stormwater Planter with subsurface storage & conveyance

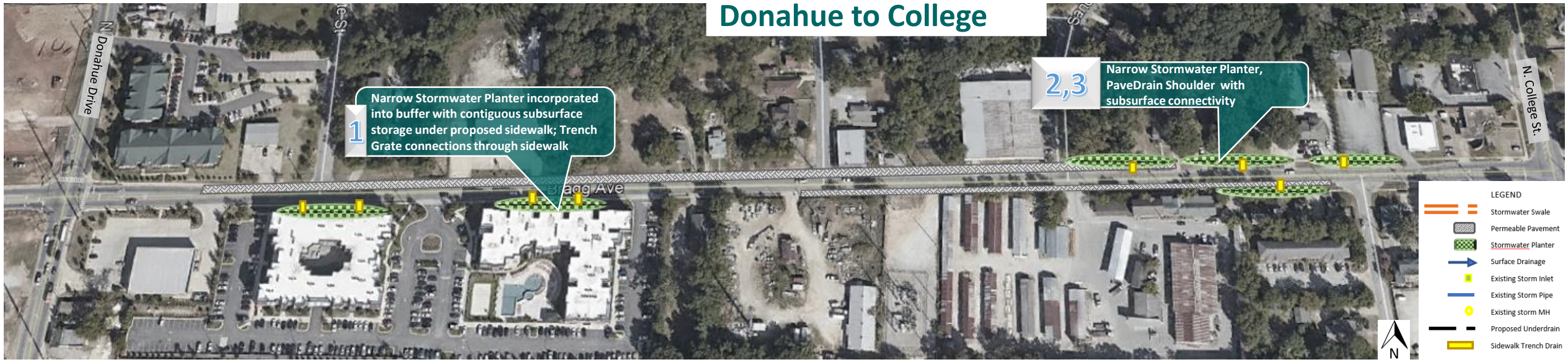
2 Stormwater Swale with bioretention plantings

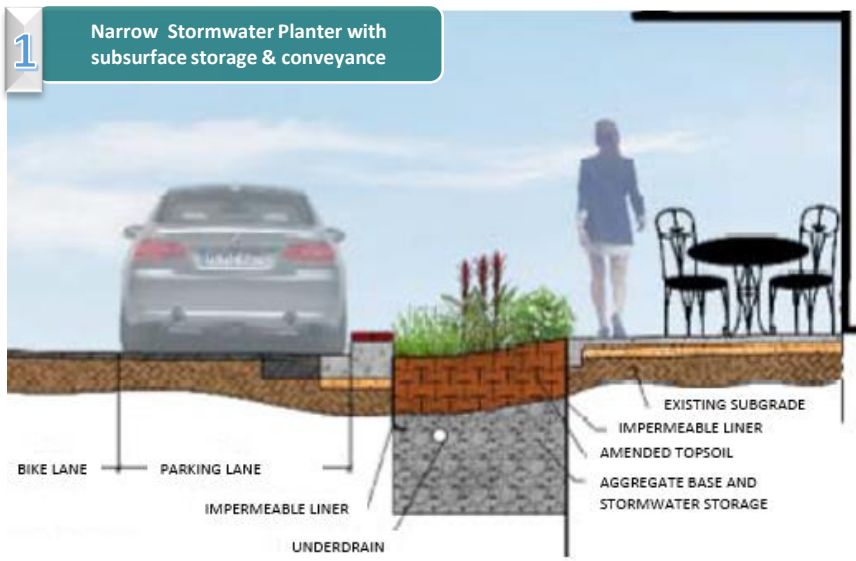
3 PaveDrain Shoulder with subsurface storage & conveyance pipe

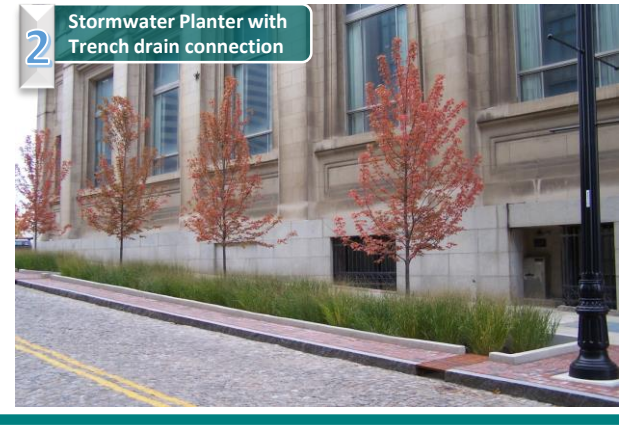
City of Auburn

GI Pilot #2 MLK Streetscape Plan

Donahue to College







City of Auburn

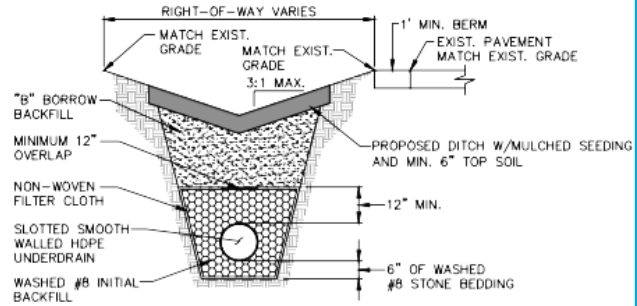
GI Pilot #2 MLK Streetscape
GI Costs & Details

GI Pilot #2 MLK Drive GI Practices

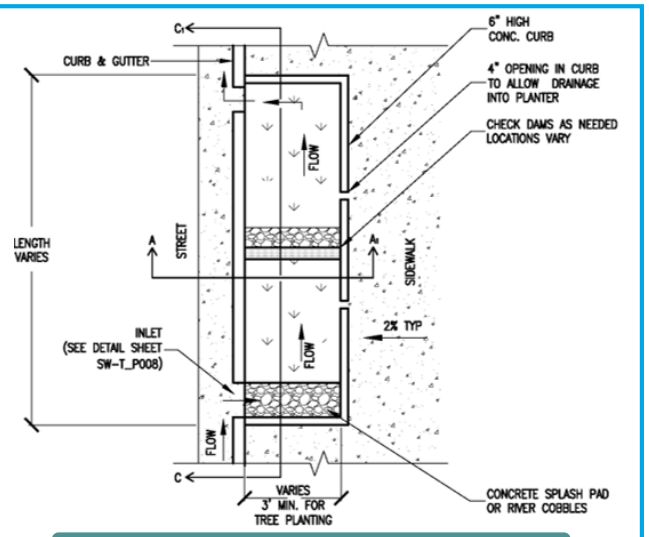
Preliminary Estimate of Probable Construction Cost - (01/2019)

GI BMP ELEMENT DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Excavation, Subgrade, for Stormwater Storage Cells	CYS	497	$15.00	$7,458.33
Coarse Aggregate Stone Paver Base, Washed	TON	269	$17.00	$4,564.50
Coarse Aggregate Washed for Standard Section	TON	727	$30.00	$21,815.63
Coarse Aggregate Washed for Stormwater Storage	TON	1,745	$30.00	$52,357.50
Geotextile Separation Fabric	SYS	2,238	$4.50	$10,068.75
3' PaveDrain Shoulder	SYS	1,492	$90.00	$134,250.00
Curb, Concrete Barrier, at Stormwater Planters	LFT	7,200	$12.00	$86,400.00
Curb Turnout, Concrete	EA	36	$500.00	$18,000.00
Underdrains 6" Pipe	LFT	15,560	$12.00	$186,720.00
Sidewalk Trench Drain	EA	8	$900.00	$7,200.00
Connect to Existing Storm Manhole	EA	8	$1,000.00	$8,000.00
Storm Structure Modification	EA	4	$500.00	$2,000.00
6" Dual Wall HDPE Storm Pipe	LFT	1,000	$26.00	$26,000.00
Nyloplast 8" Overflow Inlet	EA	14	$750.00	$10,500.00
6" Stormwater Cleanout	EA	14	$300.00	$4,200.00
Stormwater Planter Excavation/Grading (3' below existing)	CYD	3,733	$15.00	$56,000.00
Stormwater Planter stone (2')	TON	6,552	$50.00	$327,600.00
Stormwater Planter soil (18"')	CYD	1,400	$30.00	$42,000.00
Stormwater Planter Plants/shrubs (1 Gal container)	EA	1,000	$35.00	$35,000.00
Stormwater Planter Plant Plugs	EA	8,000	$12.00	$96,000.00
Stormwater Swale Grading (7485 ft)	CYD	8,871	$10.00	$88,711.11
Stormwater Swale Restoration - topsoil, seed, mulch	SYD	6,653	$12.00	$79,840.00
Planter Mulch 4"	CYD	311	$30.00	$9,333.33
Item Total				$1,314,019.15
10% Contingency				$131,401.92
Total GI BMP Estimate				**$1,445,421.07**
Engineering & CM 25%				$361,355.27

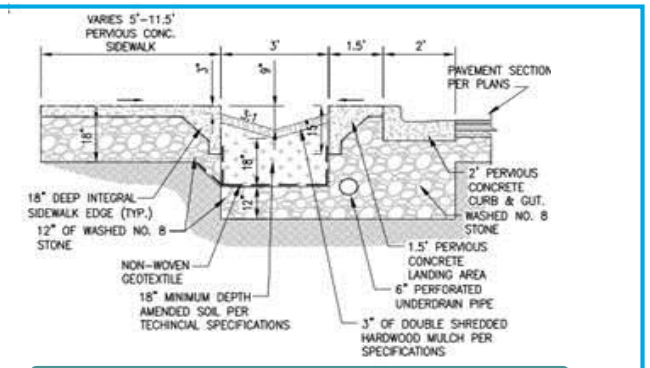
The preliminary cost estimate provided represents the anticipated conceptual cost of incorporating GI BMPs into the proposed project in lieu of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered to be part of the base project. Base project estimated costs for elements to be replaced with GI BMPs such as pavement, stormwater collection infrastructure, curb & gutter, detention, ditches, etc. can be deducted.



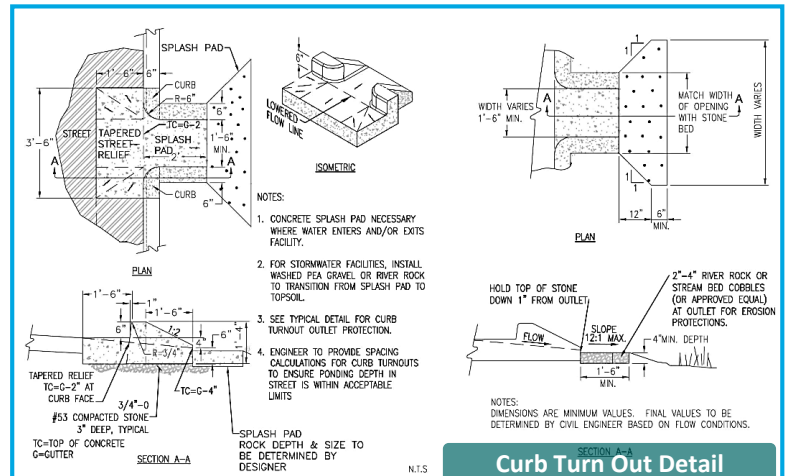
Stormwater Swale Cross Section



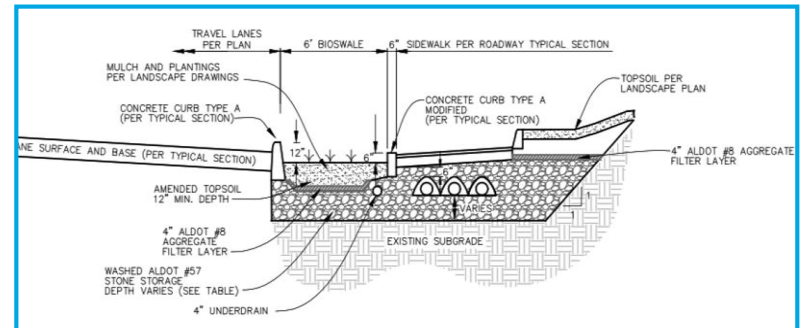
Stormwater Planter Plan Detail



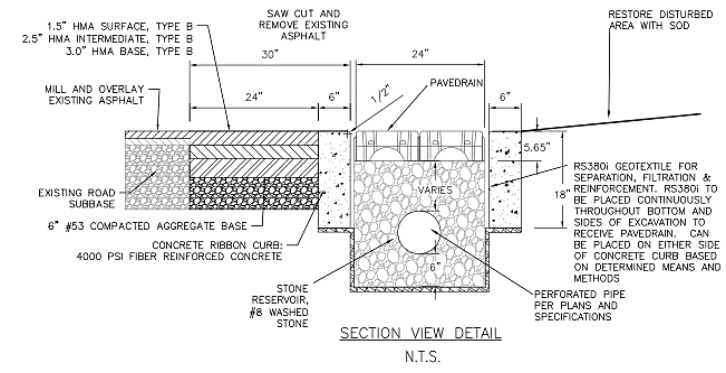
Narrow Stormwater Planter Detail



Curb Turn Out Detail



Stormwater Planter with Storage Detail



PaveDrain Shoulder Detail

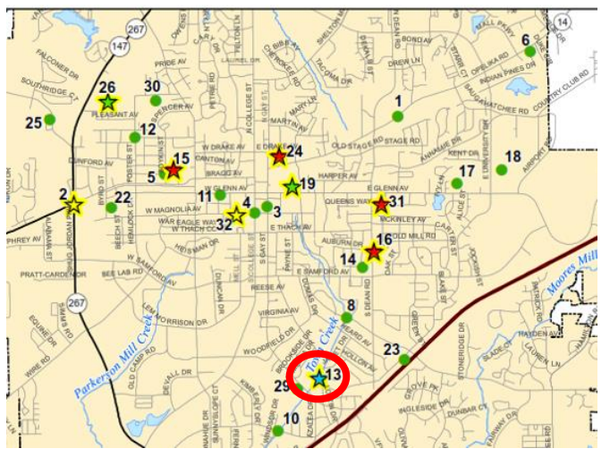
City of Auburn

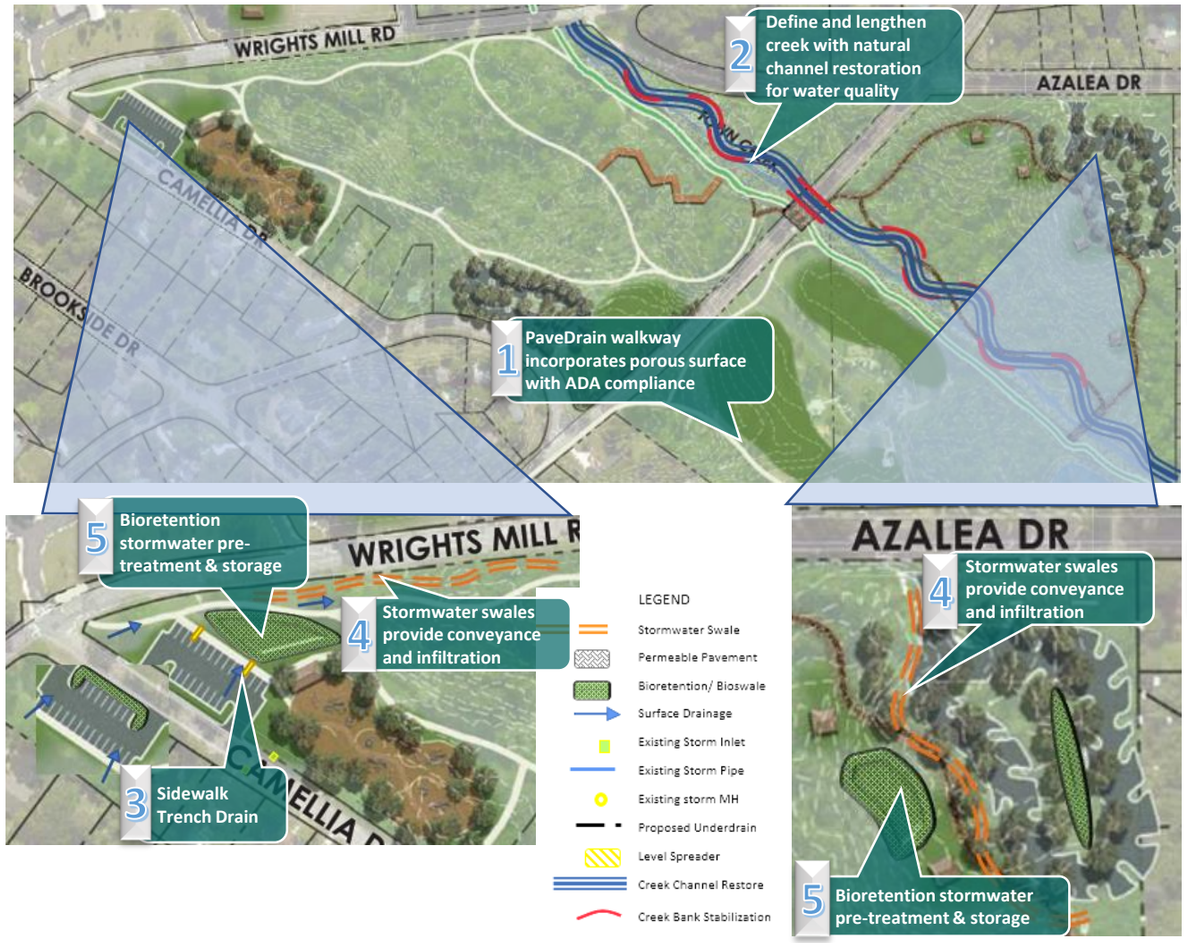
GI Pilot #13 Town Creek Park

- 70.2-acre passive park bisected by Town Creek
- Park concept plan calls for expanded trails and small shelters
- Park trails are integral to larger greenway connectivity
- Identified need for stream enhancement/restoration due to excessive lateral migration and poor bank conditions
- Offsite drainage enters site from E. Park Ave. and neighborhood to north
- Proposed woodland cleanup and trail expanded to include stormwater management
- Defining and lengthening stream channel provides water quality and habitat benefits
- Potential stream mitigation bank funding for creek restoration activity
- Wetland and Waters of the US impacts and permitting will need to be taken into consideration

Site/BMP Characteristics	
Contributing Watershed	6.05Acres
Impervious Area Managed	2.07 Acres
2-Year 24-Hour Design Storm	4.16 Inches
Volumetric Runoff Coefficient (Varies by developed sub-watershed)	70.8 – 82.3
Projected Runoff Volume	281,020 gallons
Preliminary Estimate of GI Construction Cost	$818,937
Engineering & Construction Management	$163,787
Estimated Annual Operation & Maintenance ($2500/year establishment on channel years 1-3)	$ 3750 year 1-3 $1350/year ongoing
Cost per square foot managed (Excludes creek channel restoration costs)	$ 1.29

Auburn Green Infrastructure Pilot Projects





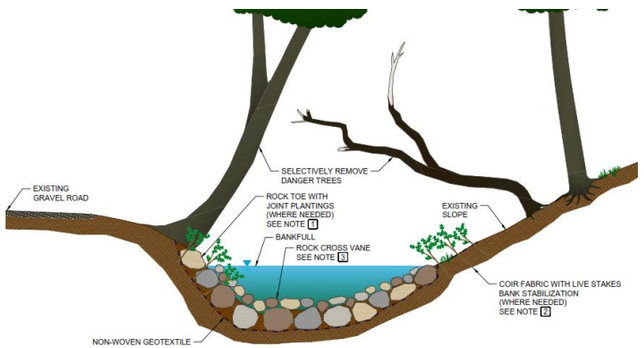

1 PaveDrain ADA compliant porous walkway


2 Creek Channel Restoration


3 Sidewalk Trench Drain


4 Stormwater swale with native plants and check dam


5 Bioretention basin on slope



Creek Channel Restoration
Not to Scale

City of Auburn

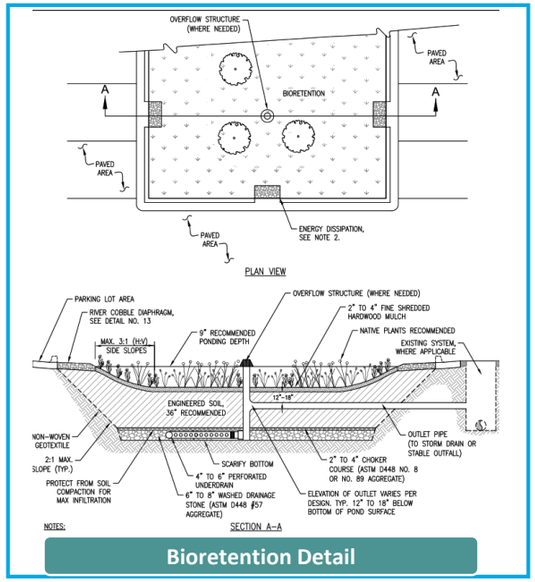
GI Pilot #13 Town Creek Park
Costs & Details

GI Pilot #13 Town Creek Park

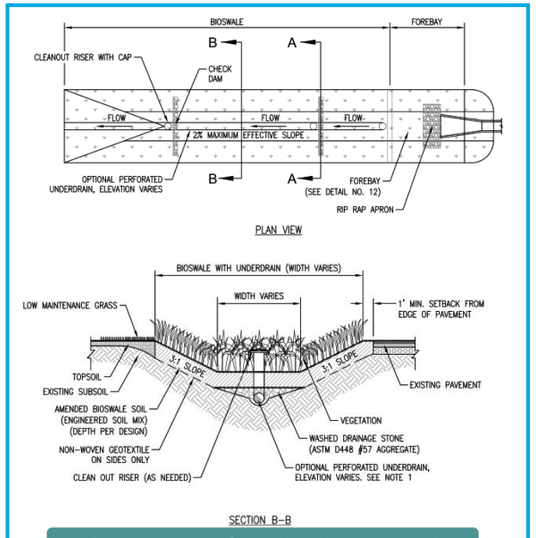
Preliminary Estimate of Probable GI Construction Cost - (01/2019)

DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Project Sign	EA	1	$1,000.00	$1,000.00
Coarse Aggregate 10" Washed for Standard Section	TON	650	$35.00	$22,750.00
Geotextile Separation Fabric	SYS	1,333	$4.50	$6,000.00
PaveDrain Walkway	SYS	1,333	$45.00	$60,000.00
Curb Turnout, Concrete	EA	4	$400.00	$1,600.00
Underdrains (6") - stormwater swale	LFT	900	$16.00	$14,400.00
Connect to Existing Storm Manhole	EA	2	$800.00	$1,600.00
Nyloplast 8" Overflow Inlet	EA	3	$750.00	$2,250.00
6" Underdrain Cleanout	EA	4	$300.00	$1,200.00
Creek Channel Resotration	LFT	2,300	$150.00	$345,000.00
Creek Bank Stabilization	SF	9,000	$15.00	$135,000.00
Sidewalk Trench Drain	EA	2	$1,100.00	$2,200.00
Bioretention Facility Excavation/Grading (2' below existing)	CYD	1,415	$10.00	$14,148.15
Bioretention Facility stone (12")	TON	1,242	$50.00	$62,075.00
Bioretention Facility soil (18")	CYD	1,061	$30.00	$31,833.33
Bioretention Facility Plants/shrubs (plugs or 1 Gal container)	EA	2,000	$15.00	$30,000.00
Stormwater Swale Grading (1000 ft)	CYD	1,185	$10.00	$11,851.85
Stormwater Swale Restoration - topsoil, seed, mulch	SYD	132	$12.00	$1,580.25
Item Total				$744,488.58
10% Contingency				$74,448.86
Total Estimate				**$818,937.44**
Engineering & CM (20%)				$163,787.49

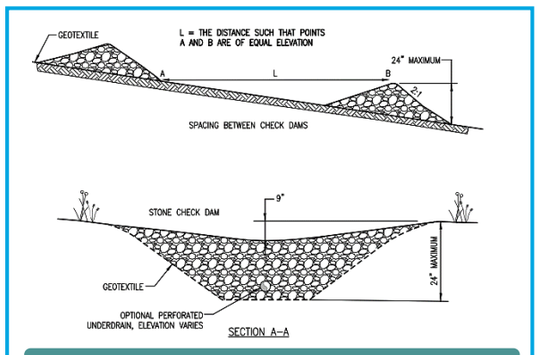
The preliminary cost estimate provided represents the anticipated conceptual cost of incorporating GI BMPs into the proposed project in lieu of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered to be part of the base project. Base project estimated costs for elements to be replaced with GI BMPs such as pavement, stormwater collection infrastructure, detention, ditches, etc. can be deducted.



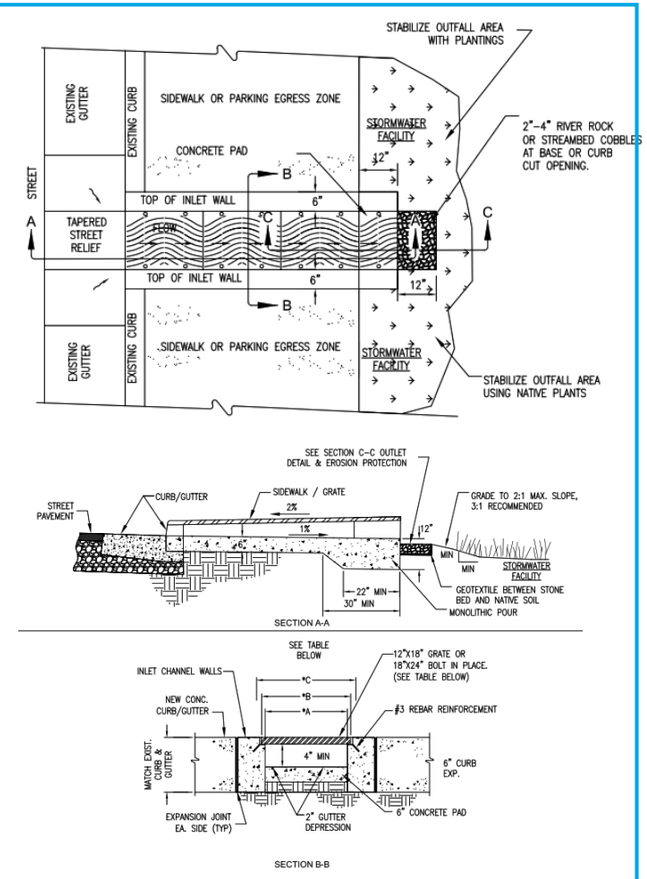
Bioretention Detail



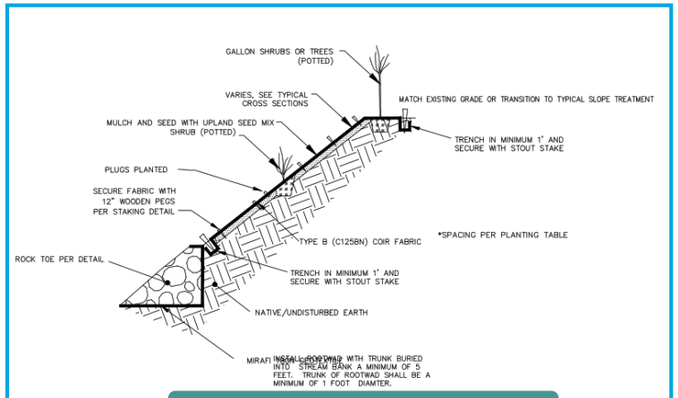
Stormwater Infiltration Swale Detail



Stormwater Swale Check Dam



Sidewalk Trench Drain Detail



Creek Bank Stabilization Detail

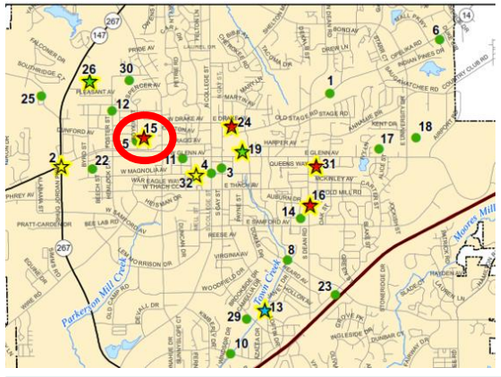
City of Auburn

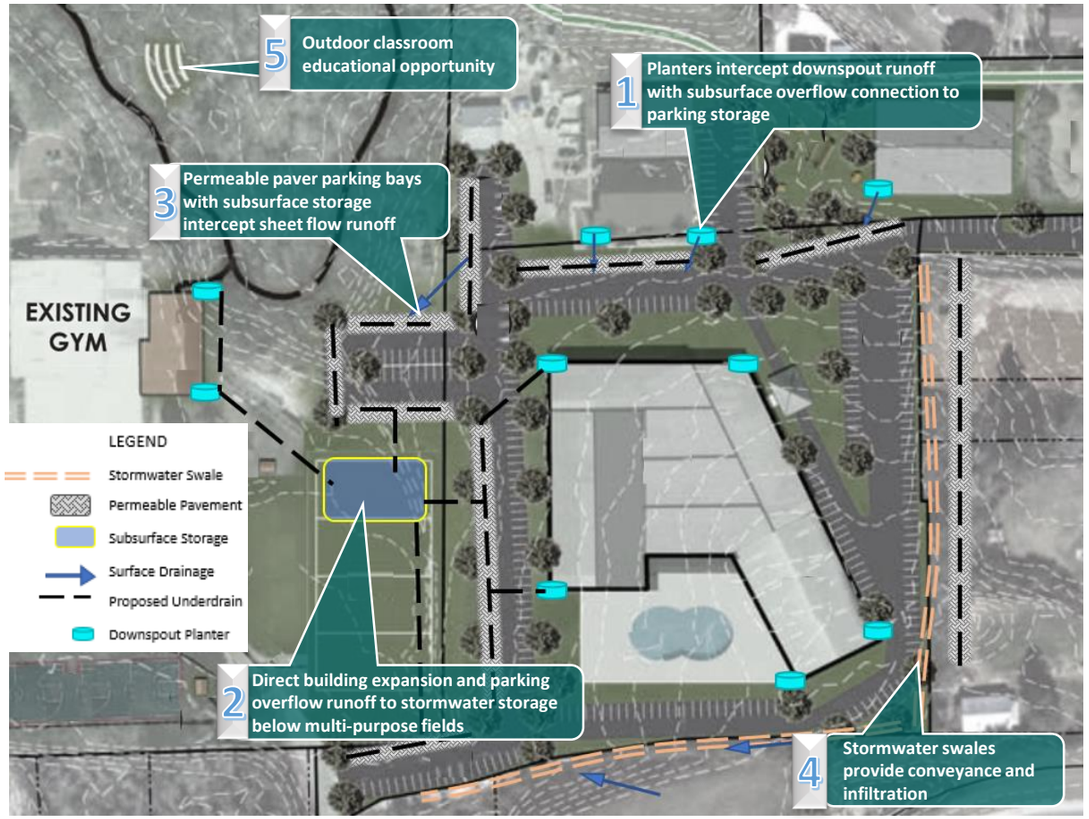
GI Pilot #15
Boykin/ Donahue Campus

- Example for Site-Based 'Facility/Campus' GI Practices
- 10.6-acre site plus adjacent 8.17-acre environmental services facility provides multiple retrofit and improvement opportunities
- GI Pilots can be phased in conjunction with long term park master plan concept
- Public location with future outdoor classroom &recycling drop off affords educational opportunities, including interactive watershed exhibits
- Parking lot surface drainage pattern is conducive to capture, treat and possible irrigation reuse
- Potential BMPs include permeable paver parking bays, stormwater swales, subsurface storage under multi-purpose play fields and use of greenspace for WQ swales
- Proposed building runoff management can be incorporated into new site features
- Conversion of White Street Detention Pond can also employ subsurface stormwater storage
- Greenway Trail can be constructed with PorousPave

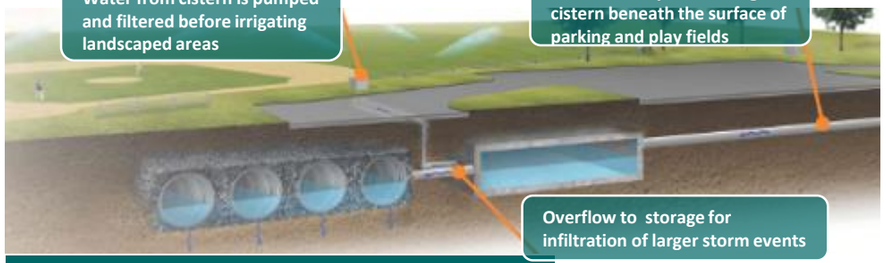
Site/BMP Characteristics	
Contributing Watershed	4.77 Acres
Impervious Area Managed	3.56 Acres
2-Year 24-Hour Design Storm	4.16 Inches
Volumetric Runoff Coefficient CN	88.6
Projected Runoff Volume	380,082 GAL
Preliminary Estimate of GI Construction Cost	$857,537
Engineering & Construction Management	$171,507
Estimated Annual Operation & Maintenance	$ 2,545
Cost per square foot of managed (80% capture)	$ 5.16
Note: O&M costs and cost/sf managed will be offset by reduced irrigation operation costs	

Auburn Green Infrastructure Pilot Projects





Permeable Paver Parking & Storage
Not to Scale



Integrated Subsurface Stormwater Storage
Not to Scale


1 Planters intercept downspout runoff. Can be planted with herbs & vegetables for community food supply.

2 Subsurface stormwater management integrated into multi purpose field


3 Permeable Paver parking with subsurface storage


4 Stormwater swale


5 Interactive Watershed Exhibit could be incorporated into outdoor classroom

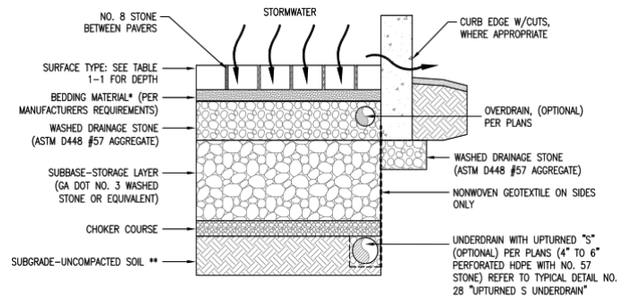
City of Auburn

GI Pilot #15 Boykin/ Donahue Campus Costs & Details

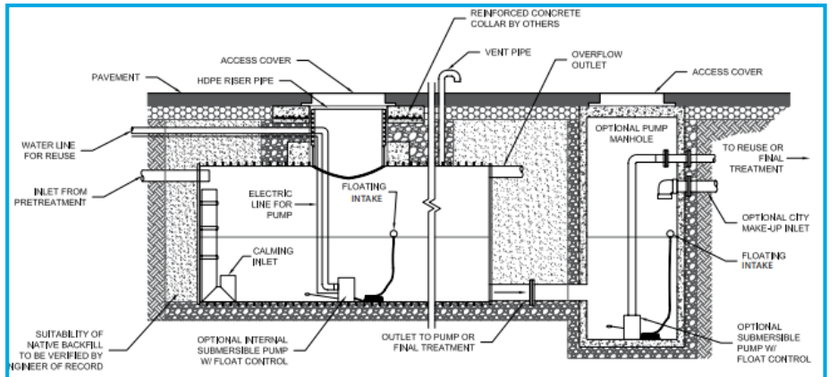
GI Pilot #15 Boykin/Donahue Campus				
Preliminary Estimate of Probable GI Construction Cost - (01/2019)				
DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Project Sign	EA	1	$1,000.00	$1,000.00
Excavation, Subgrade, for Stormwater Storage Cells	CYS	4,000	$10.00	$40,000.00
Coarse Aggregate 4" Stone Paver Base, Washed	TON	640	$17.00	$10,880.00
Coarse Aggregate 10" Washed for Standard Section	TON	1,733	$35.00	$60,666.67
Coarse Aggregate 2' Washed for Stormwater Storage	TON	4,160	$50.00	$208,000.00
Geotextile Separation Fabric	SYS	3,556	$4.50	$16,000.00
Porous Brick Pavers - parking	SYS	3,556	$45.00	$160,000.00
Curb Turnout, Concrete	EA	10	$400.00	$4,000.00
Underdrains (6") - pavers & infiltration swale	LFT	3,000	$16.00	$48,000.00
8" Dual Wall HDPE storm pipe	LFT	1,000	$35.00	$35,000.00
Connect to Existing Storm Manhole	EA	2	$800.00	$1,600.00
Nyloplast 8" Overflow Inlet	EA	4	$750.00	$3,000.00
6" Underdrain Cleanout	EA	20	$300.00	$6,000.00
StormGUARDen or similar premanufactured planter at bldg	EA	10	$2,000.00	$20,000.00
RTank or similar premanufactured storage under play fields	CFT	12,000	$6.00	$72,000.00
Rainwater Harvest & Reuse system (complete)	ALLOW	1	$80,000.00	$80,000.00
Stormwater Swale Grading (1000 ft)	CYD	1,185	$10.00	$11,851.85
Stormwater Swale Restoration - topsoil, seed, mulch	SYD	132	$12.00	$1,580.25
Item Total				$779,578.77
10% Contingency				$77,957.88
Total Estimate				**$857,536.64**
Engineering & CM (20%)				$171,507.33

The preliminary cost estimate provided represents the anticipated conceptual cost of incorporating GI BMPs into the proposed project in lieu of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered to be part of the base project. Base project estimated costs for elements to be replaced with GI BMPs such as pavement, stormwater collection infrastructure, curb & gutter, detention, ditches, etc. can be deducted.

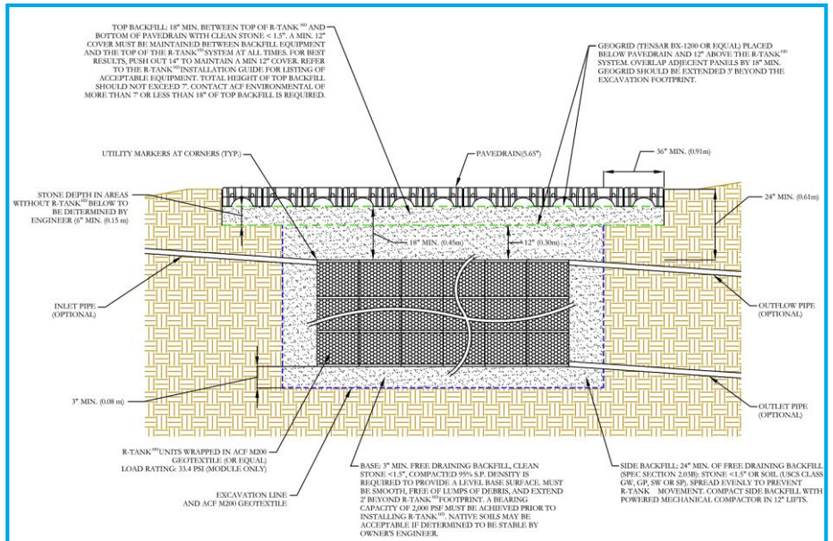
On this site, O&M costs for irrigation will be reduced as a result of the reuse system, offsetting costs for construction.



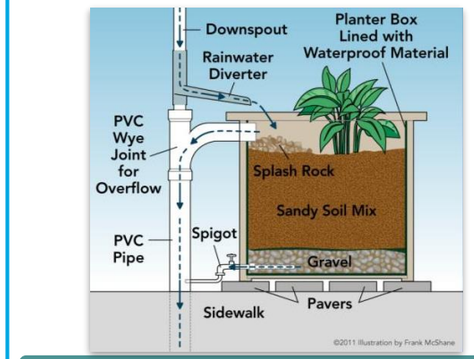
Permeable Pavement & Storage Section Detail



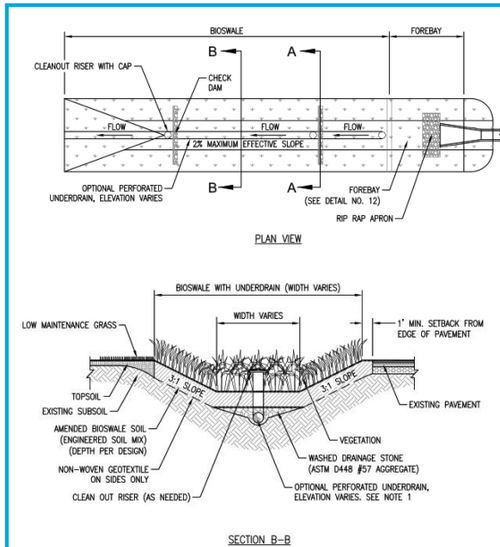
Underground Stormwater Harvesting Cistern Detail



Subsurface Storage System Detail



Downspout Planter Detail



Stormwater Swale Detail

City of Auburn

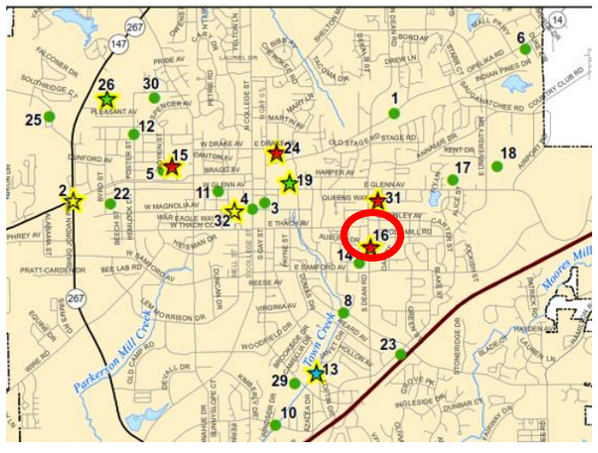
GI Pilot #16

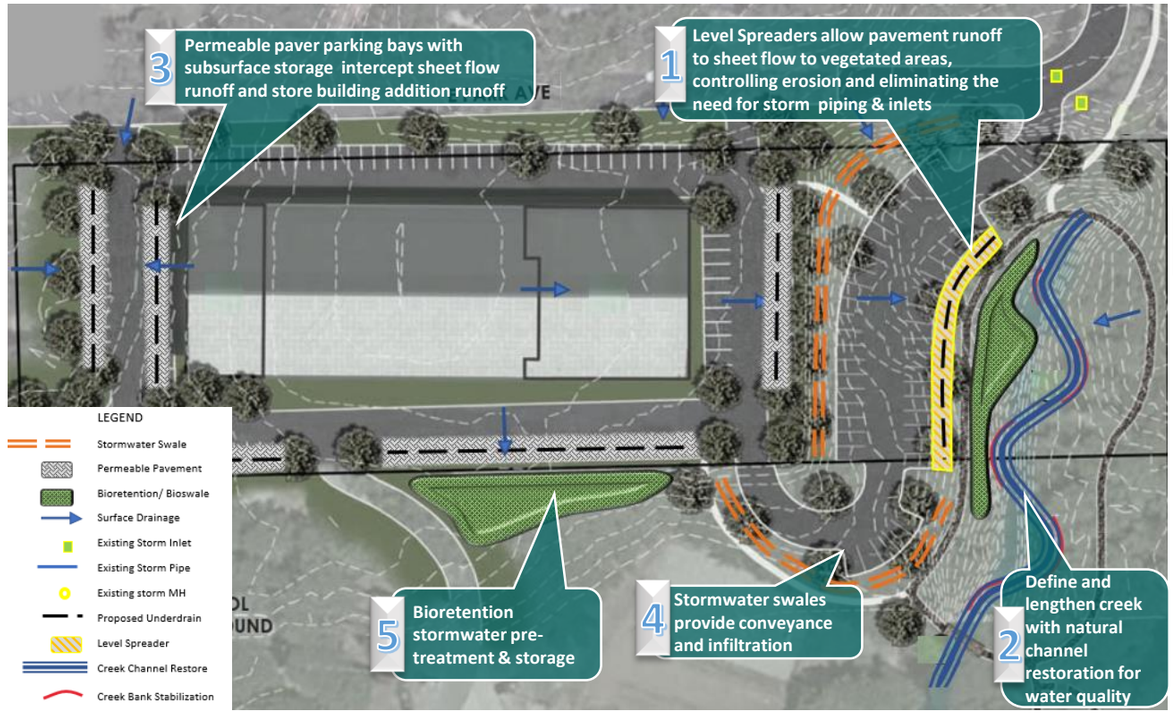
Dean Road Recreation Center

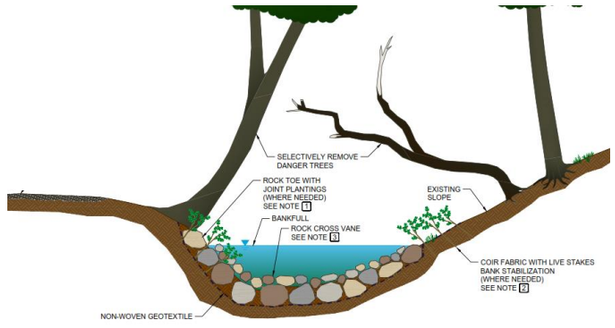
- Example for integrated site stormwater system retrofit GI practices
- 3.16-acre property with proposed concept significantly increasing impervious area
- Site has steeper slopes – design to include runoff energy dissipation using level spreaders
- Offsite drainage enters site from E. Park Ave. and neighborhood to north
- Proposed woodland cleanup and trail expanded to include stormwater management
- Defining and lengthening stream channel provides water quality and habitat benefits
- Budgeted parking and site costs can offset proposed GI costs
- Potential stream mitigation bank funding for creek restoration activity

Site/BMP Characteristics	
Contributing Watershed	2.85 Acres
Impervious Area Managed	1.91 Acres
2-Year 24-Hour Design Storm	4.16 Inches
Volumetric Runoff Coefficient CN	88.9
Projected Runoff Volume	233,308 Gallons
Preliminary Estimate of GI Construction Cost	$510,595
Engineering & Construction Management	$102,120
Estimated Annual Operation & Maintenance ($800/year establishment on channel years 1-3)	$2,025 Years 1-3 $1400/year ongoing
Cost per square foot of managed (excludes channel restoration)	$ 3.34

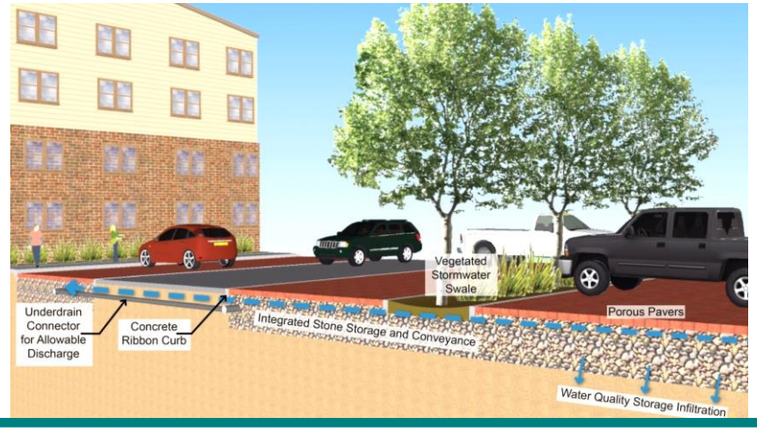
Auburn Green Infrastructure Pilot Projects

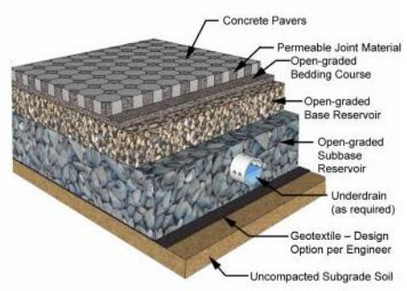






Creek Channel Restoration
Not to Scale





Permeable Paver Parking & Storage
Not to Scale

City of Auburn

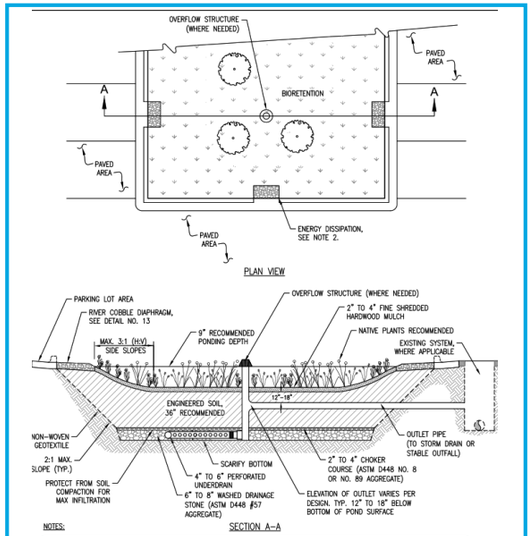
GI Pilot #16 Dean Road Rec Center Costs & Details

GI Pilot #16 Dean Road Recreation Center

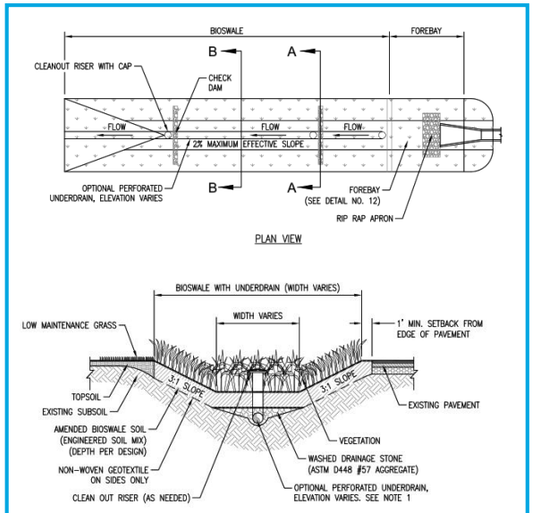
Preliminary Estimate of Probable GI Construction Cost - (01/2019)

DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Project Sign	EA	1	$1,000.00	$1,000.00
Excavation, Subgrade, for Stormwater Storage Cells	CYS	2,311	$15.00	$34,666.67
Coarse Aggregate 4" Stone Paver Base, Washed	TON	312	$17.00	$5,304.00
Coarse Aggregate 10" Washed for Standard Section	TON	845	$35.00	$29,575.00
Coarse Aggregate 2' Washed for Stormwater Storage	TON	2,028	$50.00	$101,400.00
Geotextile Separation Fabric	SYS	1,733	$4.50	$7,800.00
Porous Brick Pavers - parking	SYS	1,733	$45.00	$78,000.00
Curb Turnout, Concrete	EA	4	$400.00	$1,600.00
Underdrains (6") - pavers, level spreader & infiltration swale	LFT	1,590	$16.00	$25,440.00
Connect to Existing Storm Manhole	EA	2	$800.00	$1,600.00
Nyloplast 8" Overflow Inlet	EA	4	$750.00	$3,000.00
6" Underdrain Cleanout	EA	12	$300.00	$3,600.00
Creek Channel Resotration	LFT	400	$150.00	$60,000.00
Creek Bank Stabilization	SF	4,000	$15.00	$60,000.00
Level Spreader	LFT	200	$20.00	$4,000.00
Bioretention Facility Excavation/Grading (2' below existing)	CYD	843	$10.00	$8,425.93
Bioretention Facility stone (12")	TON	59	$50.00	$2,957.50
Bioretention Facility soil (18")	CYD	506	$30.00	$15,166.67
Bioretention Facility Plants/shrubs (plugs or 1 Gal container)	EA	1,000	$15.00	$15,000.00
Stormwater Swale Grading (420 ft)	CYD	498	$10.00	$4,977.78
Stormwater Swale Restoration - topsoil, seed, mulch	SYD	55	$12.00	$663.70
Item Total				$464,177.24
10% Contingency				$46,417.72
Total Estimate				**$510,594.96**
Engineering & CM (20%)				$102,118.99

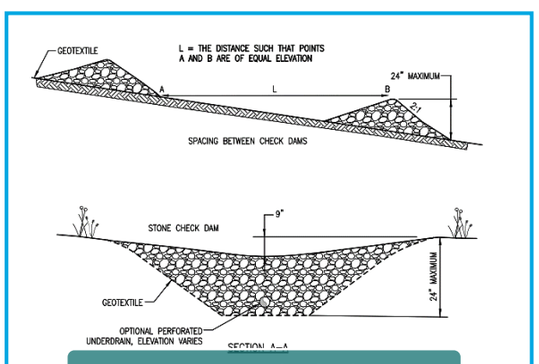
The preliminary cost estimate provided represents the anticipated conceptual cost of incorporating GI BMPs into the proposed project in lieu of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered to be part of the base project. Base project estimated costs for elements to be replaced with GI BMPs such as pavement, stormwater collection infrastructure, curb & gutter, detention, ditches, etc. can be deducted.



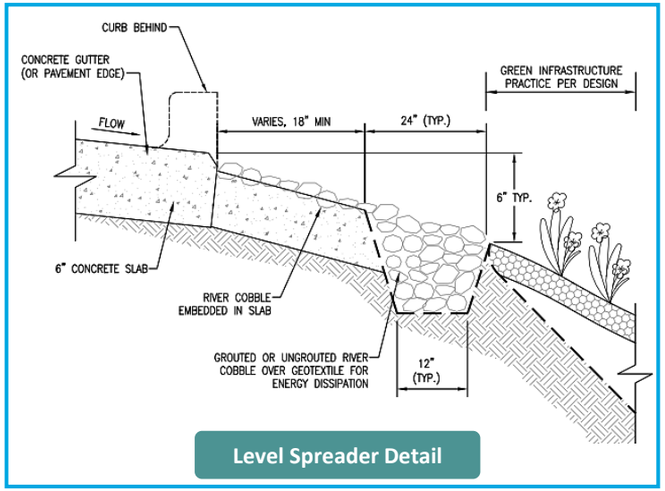
Bioretention Detail



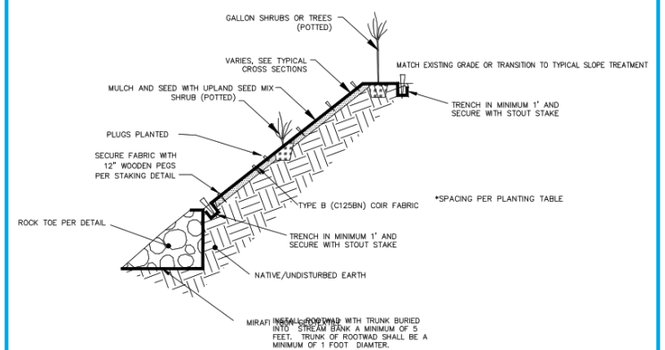
Stormwater Infiltration Swale Detail



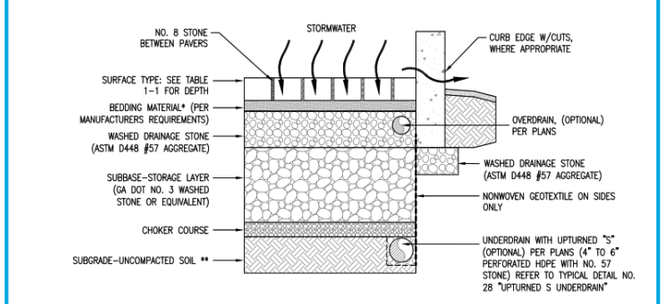
Stormwater Swale Check Dam



Level Spreader Detail



Creek Bank Stabilization Detail



Permeable Pavement & Storage Section Detail

City of Auburn

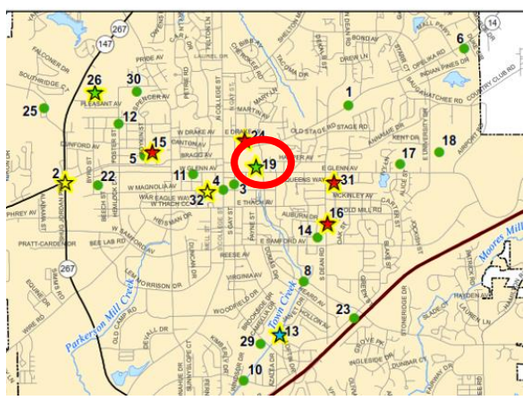
GI Pilot #19
Felton Little Park

- 8.29-acre urban area softball and neighborhood park with large detention basin at headwaters of upper Town Creek basin
- $7.6M Park concept plan adds impervious area with entry plaza, parking lots, amphitheater, pavilion, greenway trail, and farmers' market structure
- Plan includes conversion of existing detention basin into tiered 3-level wetland
- Public location affords educational opportunities including interactive watershed exhibits
- Potential BMPs include permeable paver parking bays, stormwater swales, downspout planters, and porous asphalt pathway
- Opportunity for runoff capture, treat, store and irrigation re-use (budget includes $100K allowance for irrigation/landscaping)
- Stormwater storage requirements need to be coordinated with wetland runoff assumptions
- Greenway Trail can be constructed with PorousPave

Site/BMP Characteristics	
Contributing Watershed (excludes proposed wetland watershed)	.1 Acres
Impervious Area Managed	2.12 Acres
2-Year 24-Hour Design Storm	4.16 Inches
Volumetric Runoff Coefficient CN	84.9
Projected Runoff Volume	231,362 gallons
Preliminary Estimate of GI Construction Cost	$538,857
Engineering & Construction Management	$107,772
Estimated Annual Operation & Maintenance	$2,545
Cost per square foot of managed (80% capture)	$4.71

Note: O&M costs and cost/sf managed will be offset by reduced irrigation operation costs

Auburn Green Infrastructure Pilot Projects



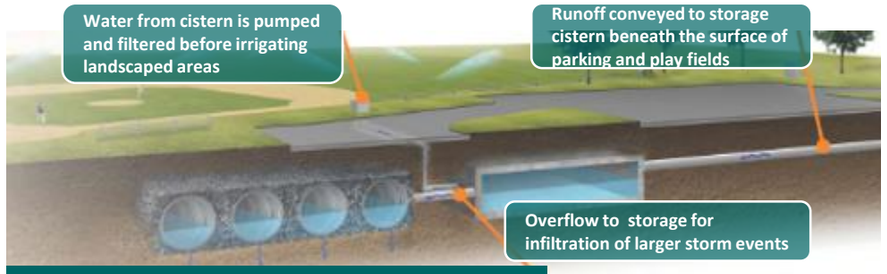

1 Planters intercept downspout runoff. Can be planted with herbs & vegetables for community food supply.

2 Subsurface stormwater management integrated into multi-purpose field

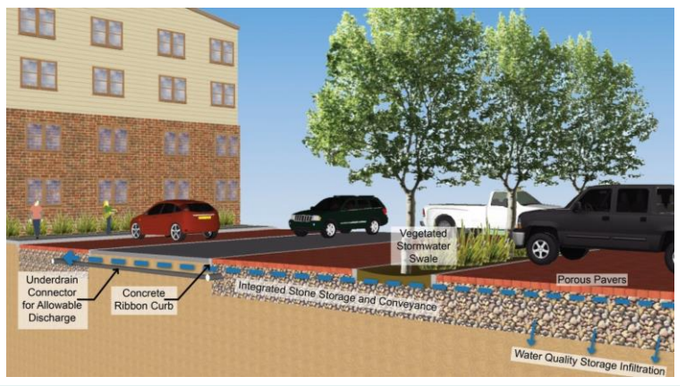

3 Permeable Paver parking with subsurface storage

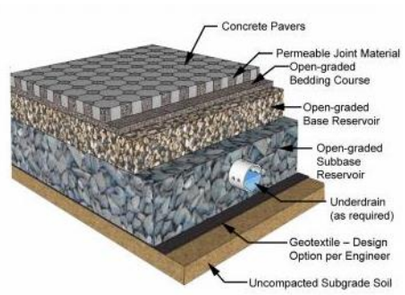

4 Stormwater swale


5 Interactive Watershed Exhibit could be incorporated into site artwork



Integrated Subsurface Stormwater Storage
Not to Scale





Permeable Paver Parking & Storage
Not to Scale

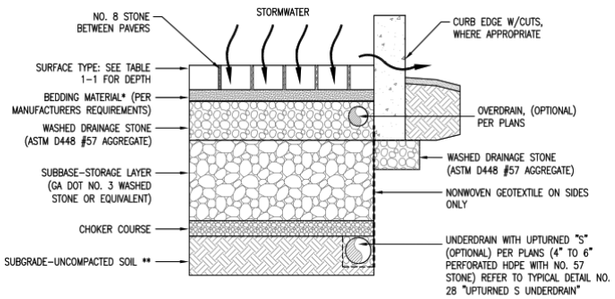
City of Auburn

GI Pilot #19 Felton Little Park Costs & Details

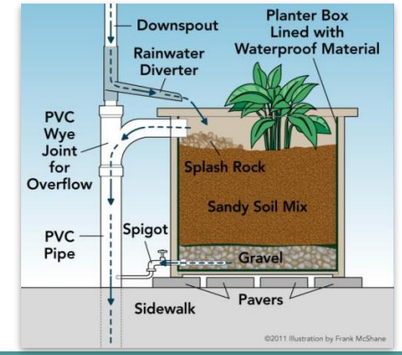
GI Pilot #19 Felton Little Park				
Preliminary Estimate of Probable GI Construction Cost - (01/2019)				
DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Project Sign	EA	1	$1,000.00	$1,000.00
Excavation, Subgrade, for Stormwater Storage Cells	CYS	1,904	$15.00	$28,555.56
Coarse Aggregate 4" Stone Paver Base, Washed	TON	236	$17.00	$4,012.00
Coarse Aggregate 10" Washed for Standard Section	TON	639	$35.00	$22,370.83
Coarse Aggregate 2' Washed for Stormwater Storage	TON	2,301	$50.00	$115,050.00
Geotextile Separation Fabric	SYS	1,311	$4.50	$5,900.00
Porous Brick Pavers - parking	SYS	1,311	$45.00	$59,000.00
Curb Turnout, Concrete	EA	2	$400.00	$800.00
Underdrains (6") - pavers & infiltration swale	LFT	2,000	$16.00	$32,000.00
8" Dual Wall HDPE storm pipe	LFT	600	$35.00	$21,000.00
Connect to Existing Storm Manhole	EA	1	$800.00	$800.00
Nyloplast 8" Overflow Inlet	EA	1	$750.00	$750.00
6" Underdrain Cleanout	EA	4	$300.00	$1,200.00
StormGUARDen or similar premanufactured planter at bldg	EA	4	$2,000.00	$8,000.00
RTank or similar premanufactured storage under play fields	CFT	16,000	$6.00	$96,000.00
Rainwater Harvest & Reuse system (complete)	ALLOW	1	$80,000.00	$80,000.00
Stormwater Swale Grading (1000 ft)	CYD	1,185	$10.00	$11,851.85
Stormwater Swale Restoration - topsoil, seed, mulch	SYD	132	$12.00	$1,580.25
Item Total				$489,870.49
10% Contingency				$48,987.05
Total Estimate				**$538,857.54**
Engineering & CM (20%)				$107,771.51

The preliminary cost estimate provided represents the anticipated conceptual cost of incorporating GI BMPs into the proposed project in lieu of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered to be part of the base project. Base project estimated costs for elements to be replaced with GI BMPs such as pavement, stormwater collection infrastructure, curb & gutter, detention, ditches, etc. can be deducted.

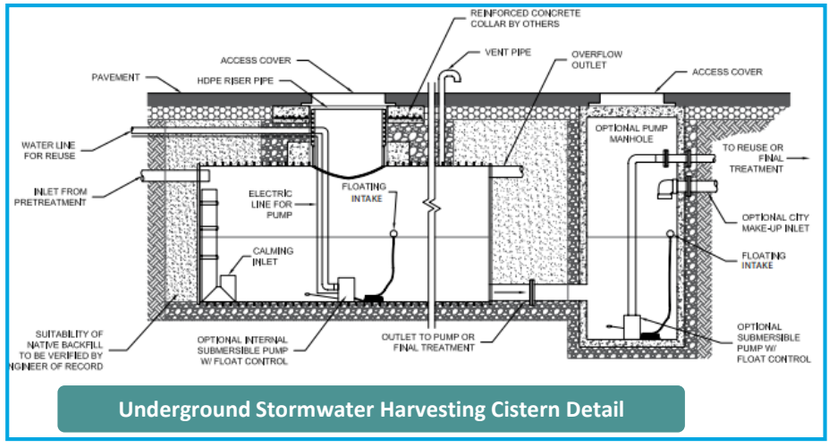
On this site, O&M costs for irrigation will be reduced as a result of the reuse system, offsetting costs for construction.



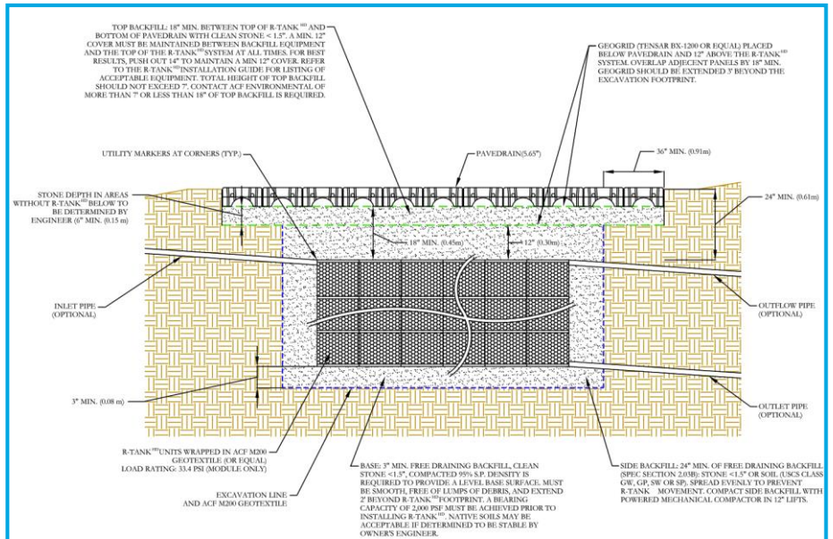
Permeable Pavement & Storage Section Detail



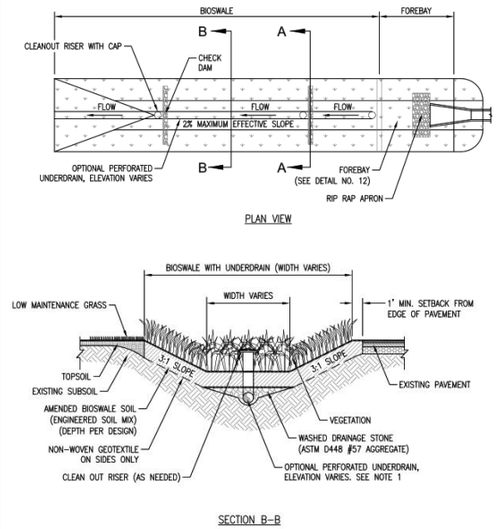
Downspout Planter Detail



Underground Stormwater Harvesting Cistern Detail



Subsurface Storage System Detail



Stormwater Swale Detail

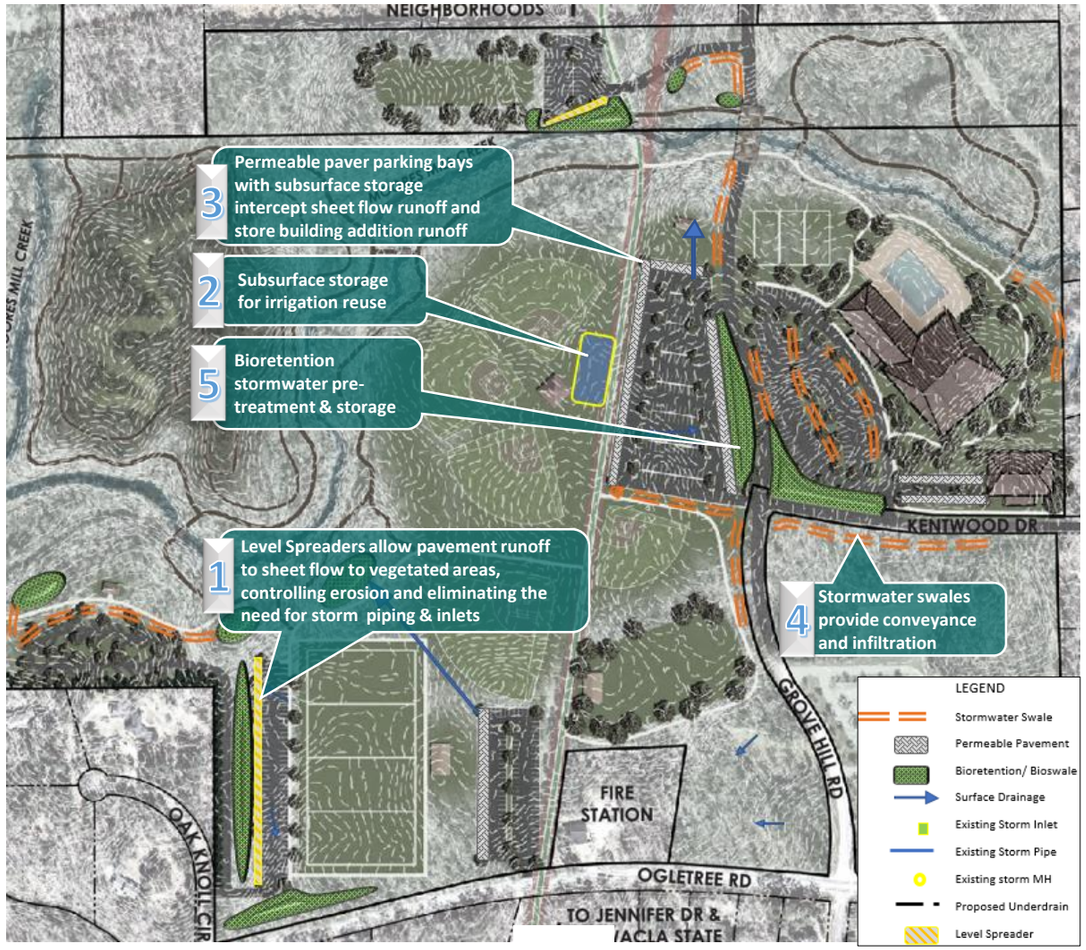
City of Auburn

GI Pilot #21 Lake Wilmore Park

- 208.38-acre park facility with multiple proposed uses and added impervious surface
- Large scale project with $7.1M budget, outside of core metro area
- Opportunities for roadway integrated GI BMP example with Grove Hill and Kentwood Drive extensions
- Potential BMPs include permeable paver parking bays, stormwater swales, bioretention, level spreaders, and subsurface storage
- Opportunity for runoff capture, treat, store and irrigation re-use (budget includes $95K allowance for irrigation/landscaping and $125K for utilites/ drainage)
- Use of integrated site stormwater management for collection, conveyance, and storage will reduce/eliminate the need for traditional piping, inlets and manholes and curb and gutter
- Opportunity to incorporate stream channel restoration into project

Site/BMP Characteristics	
Contributing Watershed (for proposed development plan)	43.8 Acres
Impervious Area Managed	22.3 Acres
2-Year 24-Hour Design Storm	4.16 Inches
Volumetric Runoff Coefficient CN (Varies by developed sub-watershed)	69-88
Projected Runoff Volume	2.59M gallons
Preliminary Estimate of GI Construction Cost	$2,289,587
Engineering & Construction Management	$457,917
Estimated Annual Operation & Maintenance	$5,950
Cost per square foot managed	$ 1.20

Note: O&M costs and cost/sf managed will be offset by reduced irrigation operation costs




1 Level Spreaders dissipate stormwater runoff energy to protect from erosion

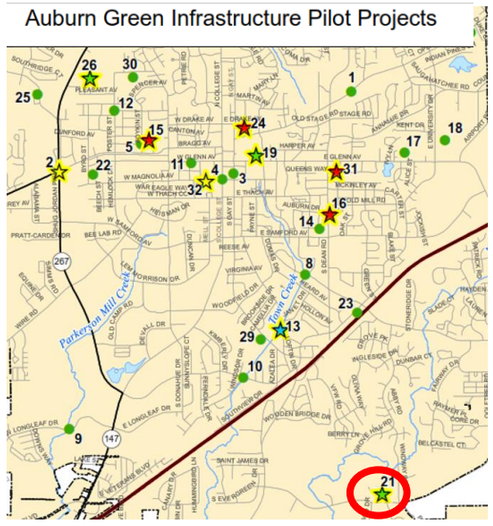
2 Subsurface storage for irrigation reuse

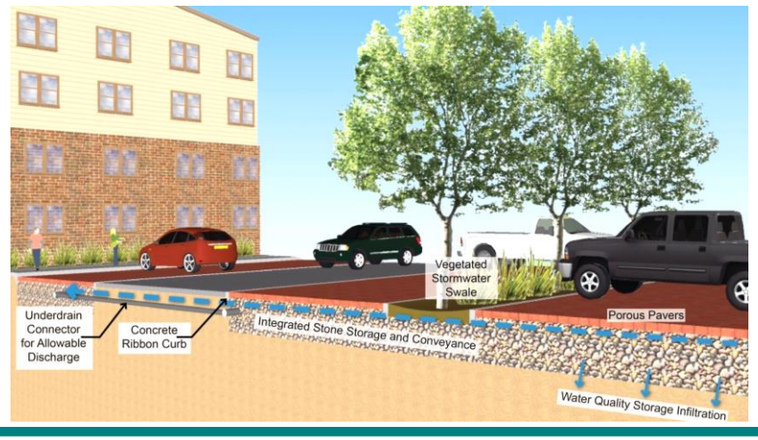

3 Permeable Paver parking with subsurface storage

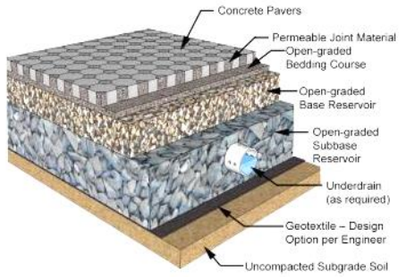

4 Stormwater swale


5 Bioretention basin on steeper slope

Auburn Green Infrastructure Pilot Projects







Permeable Paver Parking & Storage
Not to Scale

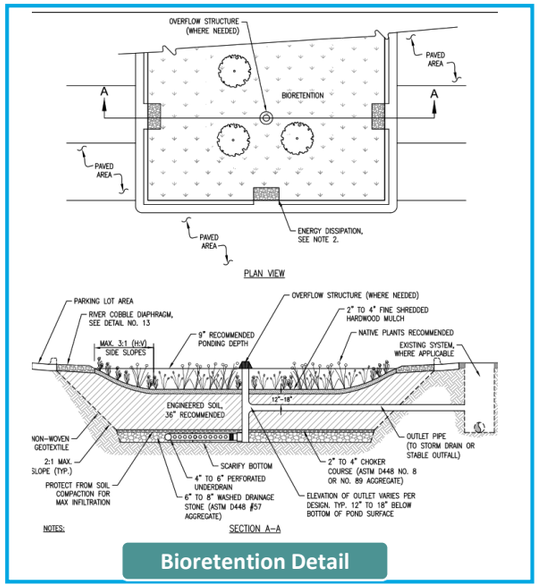
City of Auburn

GI Pilot #21 Lake Wilmore Park Costs & Details

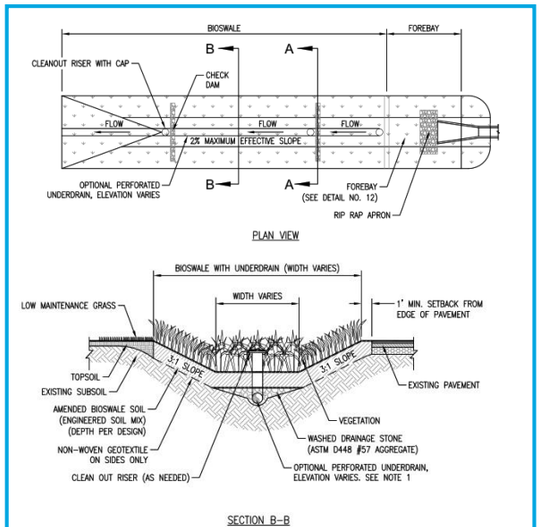
GI Pilot #21 Lake Wilmore Park				
Preliminary Estimate of Probable GI Construction Cost - (01/2019)				
DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Project Sign	EA	1	$1,000.00	$1,000.00
Excavation, Subgrade, for Stormwater Storage Cells	CYS	3,644	$10.00	$36,444.44
Coarse Aggregate 4" Stone Paver Base, Washed	TON	656	$17.00	$11,152.00
Coarse Aggregate 10" Washed for Standard Section	TON	1,777	$35.00	$62,183.33
Coarse Aggregate 2' Washed for Stormwater Storage	TON	4,264	$50.00	$213,200.00
Geotextile Separation Fabric	SYS	3,644	$4.50	$16,400.00
Porous Brick Pavers - parking	SYS	3,644	$45.00	$164,000.00
Curb Turnout, Concrete	EA	25	$400.00	$10,000.00
Underdrains (6") - pavers & infiltration swale	LFT	5,500	$16.00	$88,000.00
Nyloplast 8" Overflow Inlet	EA	12	$750.00	$9,000.00
6" Underdrain Cleanout	EA	20	$300.00	$6,000.00
Rainwater Harvest & Reuse system (complete)	ALLOW	1	$80,000.00	$80,000.00
RTank or similar premanufactured storage	CFT	88,000	$6.00	$528,000.00
Bioretention Facility Excavation/Grading (3' below existing)	CYD	11,897	$10.00	$118,966.67
Bioretention Facility stone (12")	TON	6,960	$50.00	$347,977.50
Bioretention Facility soil (18"')	CYD	5,948	$30.00	$178,450.00
Bioretention Facility Plants/shrubs (plugs or 1 Gal container)	EA	11,000	$15.00	$165,000.00
Stormwater Swale Grading (3400 ft)	CYD	4,030	$10.00	$40,296.30
Stormwater Swale Restoration - topsoil, seed, mulch	SYD	448	$12.00	$5,372.84
Item Total				$2,081,443.08
10% Contingency				$208,144.31
Total Estimate				**$2,289,587.39**
Engineering & CM (20%)				$457,917.48

The preliminary cost estimate provided represents the anticipated conceptual cost of incorporating GI BMPs into the proposed project in lieu of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered to be part of the base project. Base project estimated costs for elements to be replaced with GI BMPs such as pavement, stormwater collection infrastructure, curb & gutter, detention, ditches, etc. can be deducted.

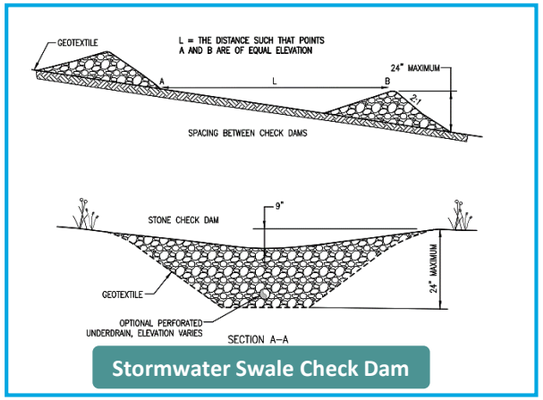
On this site, O&M costs for irrigation will be reduced as a result of the reuse system, offsetting costs for construction.



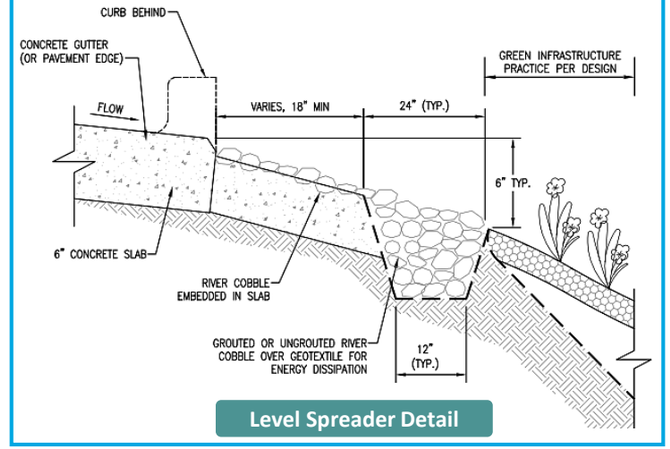
Bioretention Detail



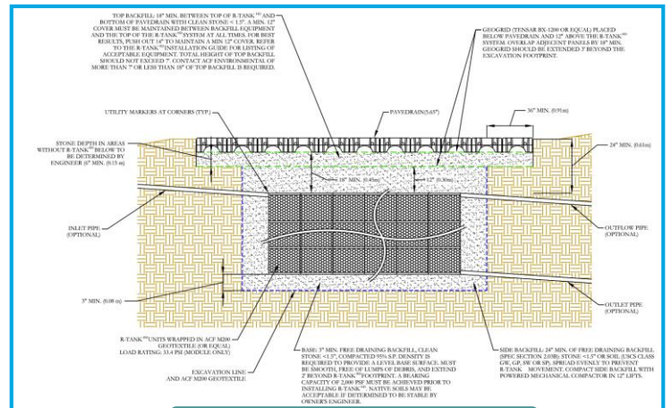
Stormwater Infiltration Swale Detail



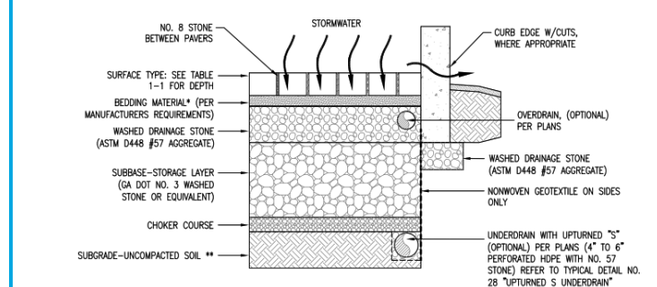
Stormwater Swale Check Dam



Level Spreader Detail



Subsurface Storage System Detail



Permeable Pavement & Storage Section Detail

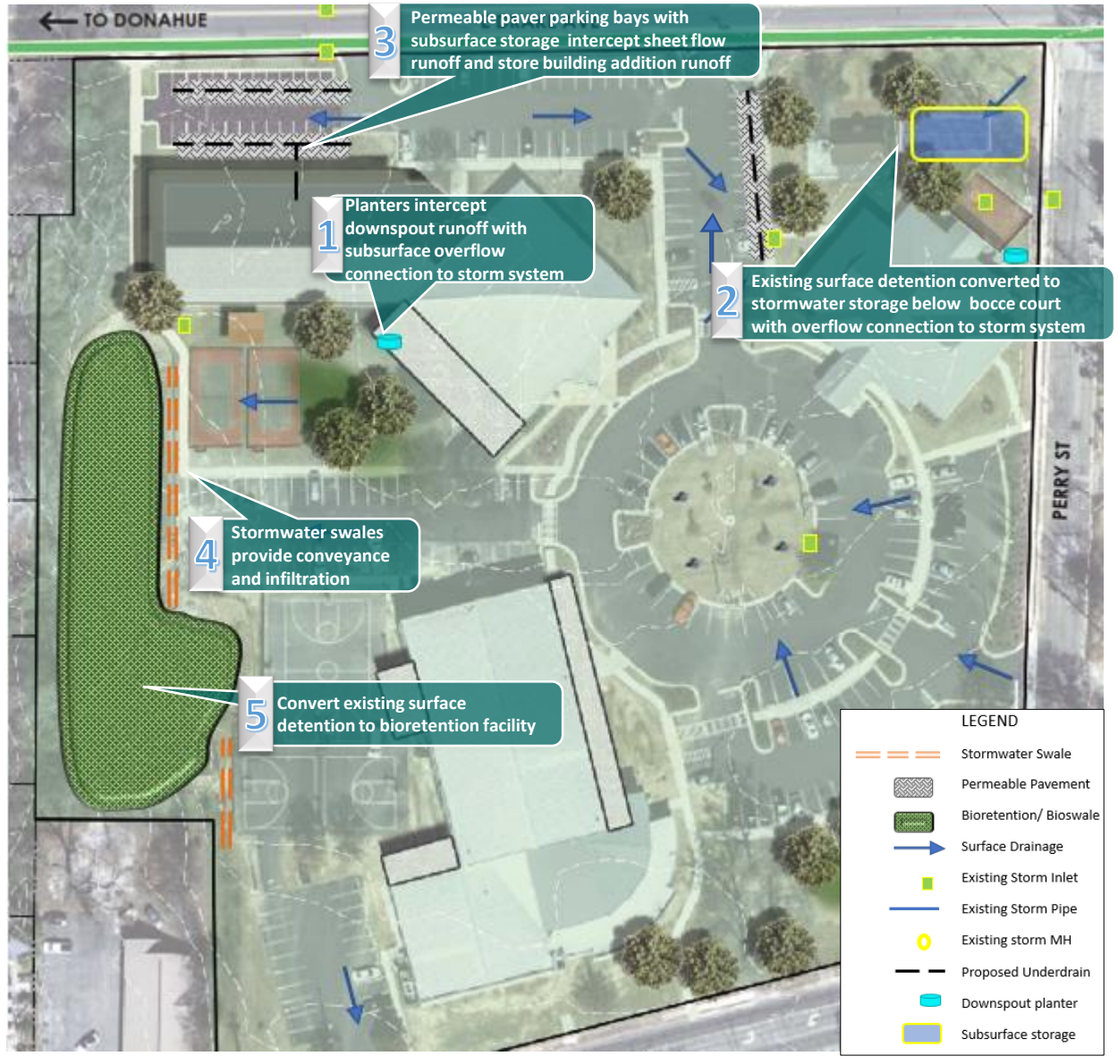
City of Auburn

GI Pilot #24

Parks & Rec Main Campus

- Example for existing site stormwater system retrofit GI practices
- 7.48-acre property with significant existing facilities and parking
- Proposed concept increases impervious area with building additions and parking expansion – full site cannot be managed to design storm without significant retrofits
- Budgeted parking and site costs can offset proposed GI costs
- Existing parking, walks and landscape are in good condition
- Existing stormwater system includes detention pond on west portion of site and large inlets providing surface detention storage within site
- Existing stormwater storage will be impacted by proposed plan
- Detention pond performance can be maximized and steep slopes mitigated by converting existing surface system to bioretention facility

Site/BMP Characteristics	
Contributing Watershed	6.1 Acres
Impervious Area (NOTE: Full site cannot be managed to design storm)	3.97 acres
2-Year 24-Hour Design Storm	4.16 Inches
Volumetric Runoff Coefficient CN	85.1
Projected Runoff Volume	431,619 Gallons
Preliminary Estimate of GI Construction Cost	$401,322
Engineering & Construction Management	$80,264
Estimated Annual Operation & Maintenance	$1500
Cost per square foot of managed	$ 1.51
*Proposed Plan does not consider any offsite storage requirements in existing detention facility	




1 Planters intercept downspout runoff. Can be planted with herbs & vegetables for community food supply

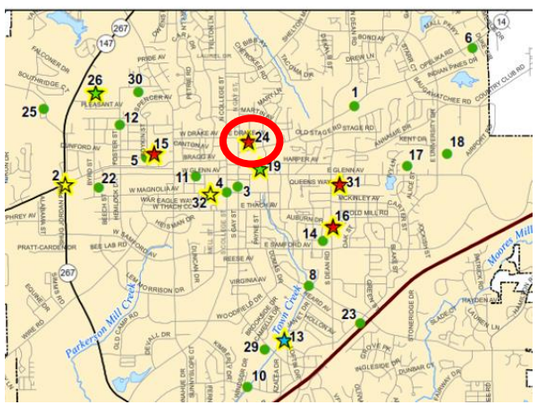
2 Subsurface stormwater management integrated into site amenity

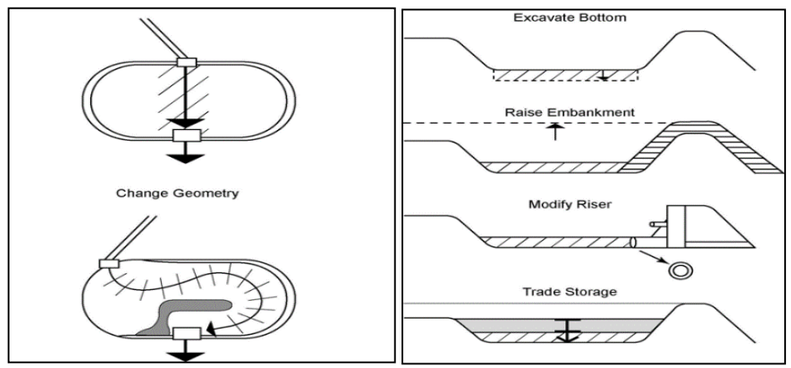

3 Permeable Paver parking with subsurface storage


4 Stormwater swale


5 Surface detention converted to bioretention basin

Auburn Green Infrastructure Pilot Projects





Detention Pond Retrofit
Not to Scale

Permeable Paver Parking & Storage
Not to Scale

City of Auburn

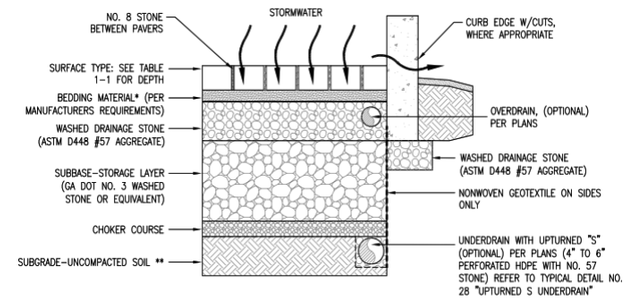
GI Pilot #24 Parks & Rec Main Campus Costs & Details

GI Pilot #21 Parks & Recreation Main Campus

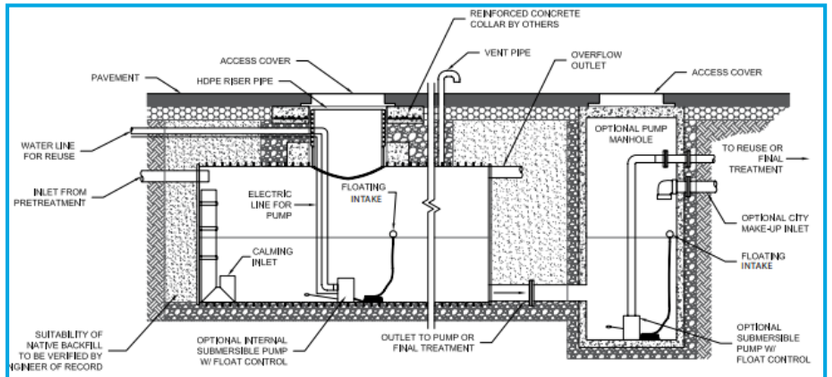
Preliminary Estimate of Probable GI Construction Cost - (12/19/2018)

DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Project Sign	EA	1	$1,000.00	$1,000.00
Excavation, Subgrade, for Stormwater Storage Cells	CYS	822	$15.00	$12,333.33
Coarse Aggregate 4" Stone Paver Base, Washed	TON	148	$17.00	$2,516.00
Coarse Aggregate 10" Washed for Standard Section	TON	401	$35.00	$14,029.17
Coarse Aggregate 3' Washed for Stormwater Storage	TON	1,443	$50.00	$72,150.00
Geotextile Separation Fabric	SYS	822	$4.50	$3,700.00
Porous Brick Pavers - parking	SYS	822	$45.00	$37,000.00
Curb Turnout, Concrete	EA	2	$400.00	$800.00
Underdrains (6") - pavers & infiltration swale	LFT	400	$16.00	$6,400.00
Connect to Existing Storm Manhole	EA	2	$800.00	$1,600.00
Nyloplast 8" Overflow Inlet	EA	2	$750.00	$1,500.00
6" Underdrain Cleanout	EA	4	$300.00	$1,200.00
StormGUARDen or similar premanufactured planter at bldg	EA	2	$2,000.00	$4,000.00
RTank or similar premanufactured storage under Bocce & adjacent	CFT	16,000	$6.00	$96,000.00
Bioretention Facility Excavation/Grading (2' below existing)	CYD	844	$10.00	$8,444.44
Bioretention Facility stone (2')	TON	1,430	$50.00	$71,500.00
Bioretention Facility soil (3')	CYD	1,267	$30.00	$38,000.00
Bioretention Facility Plants/shrubs (plugs or 1 Gal container)	EA	750	$15.00	$11,250.00
Stormwater Swale Grading (200 ft)	CYD	237	$10.00	$2,370.37
Stormwater Swale Restoration - topsoil, seed, mulch	SYD	26	$12.00	$316.05
Item Total				$386,109.36
10% Contingency				$38,610.94
Total Estimate				**$424,720.30**
Engineering & CM (20%)				$84,944.06

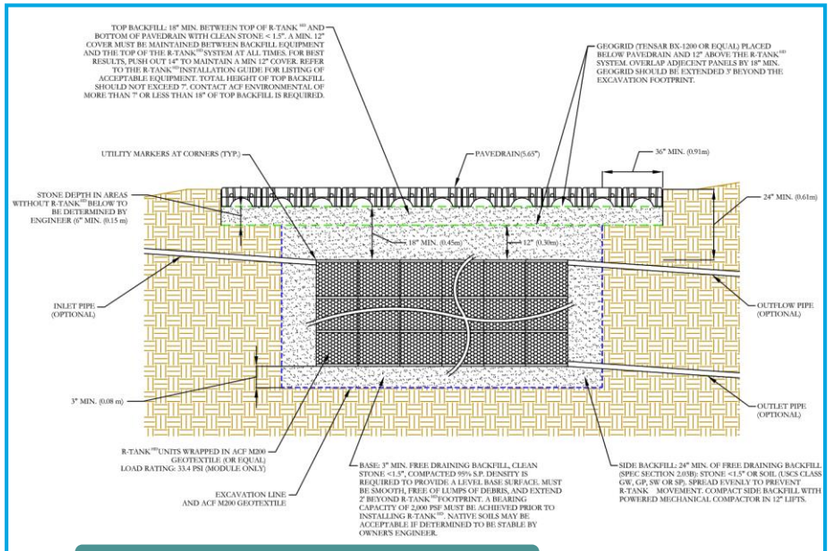
The preliminary cost estimate provided represents the anticipated conceptual cost of incorporating GI BMPs into the proposed project in lieu of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered to be part of the base project. Base project estimated costs for elements to be replaced with GI BMPs such as pavement, stormwater collection infrastructure, curb & gutter, detention, ditches, etc. can be deducted.



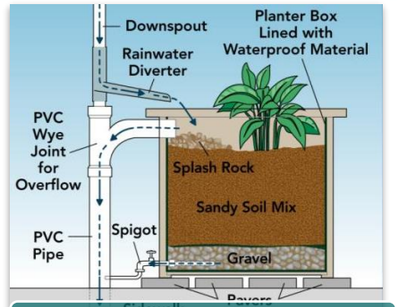
Permeable Pavement & Storage Section Detail



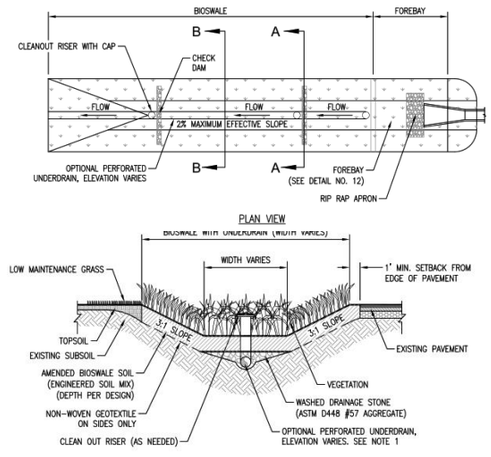
Underground Stormwater Harvesting Cistern Detail



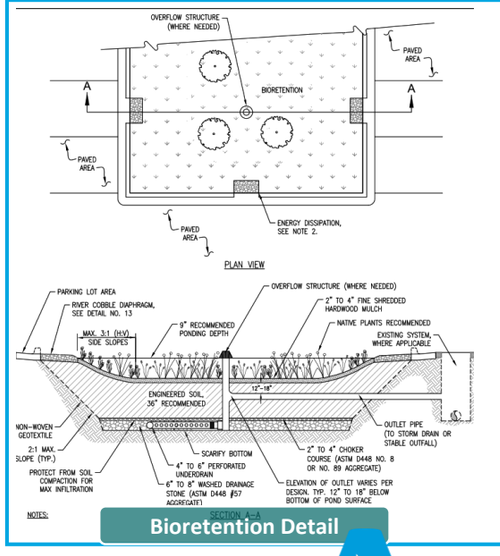
Subsurface Storage System Detail



Downspout Planter Detail



Stormwater Swale Detail



Bioretention Detail

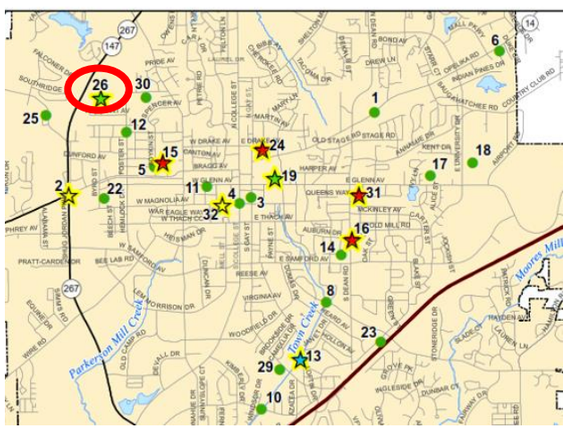
City of Auburn

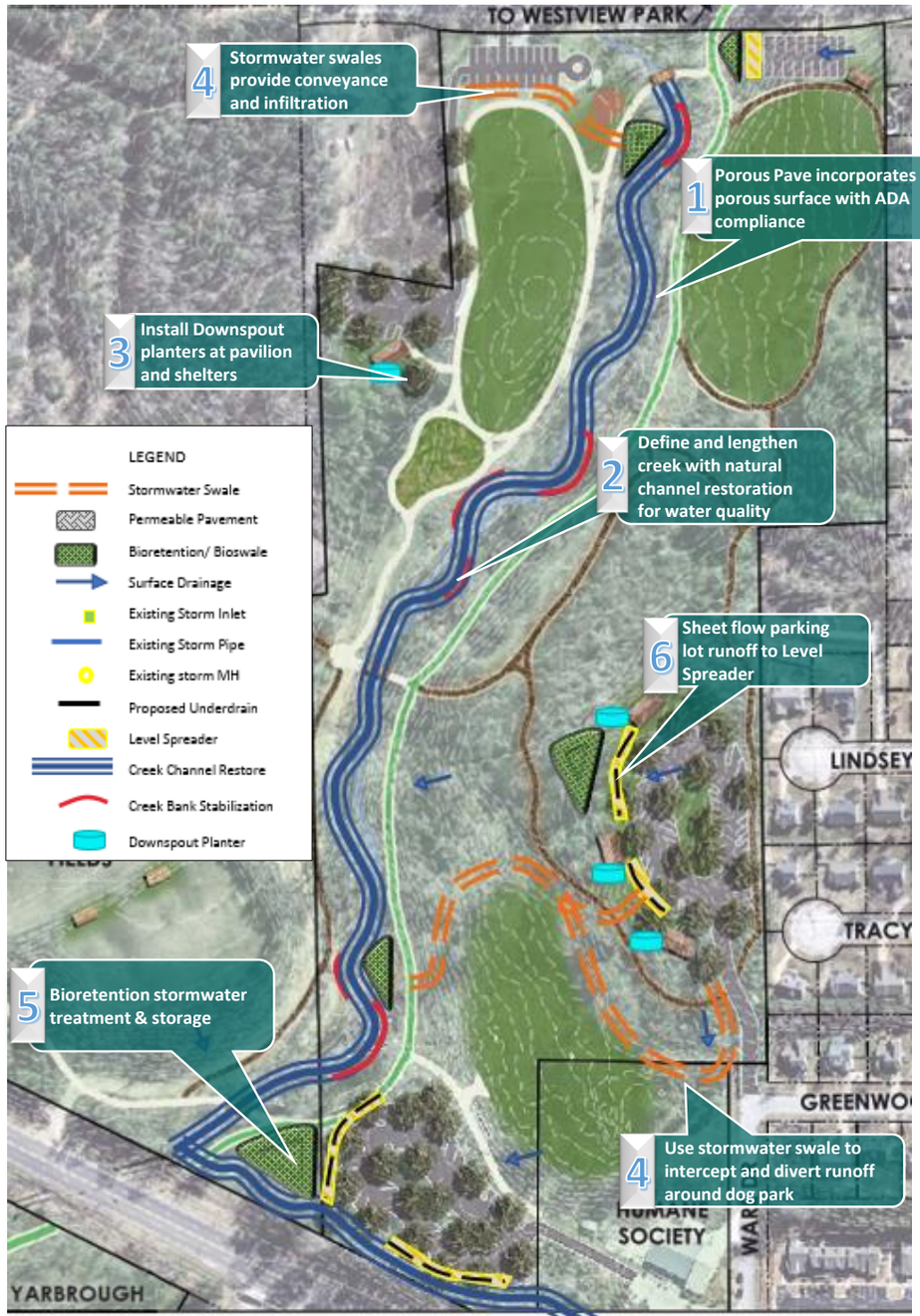
GI Pilot #26 Sam Harris Park

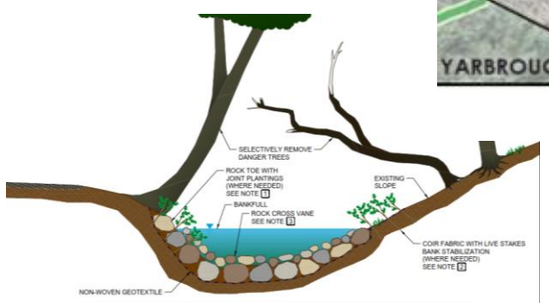
- 30.14-acre project with adjacent 19.81-acre Shug Jordan soccer fields
- Project has $300K per year budget for 3 years
- Park concept plan calls for greenway and trail system, shelters, parking and drives. Does not incorporate significant impervious area
- Potential to mitigate TMDL impaired outfall through stream restoration of the unnamed tributary to Saugahatchee creek (draft 2018 report included pathogens)
- Provide stormwater collection/reuse for irrigation of proposed community garden
- Opportunity to integrate GI BMPs into the proposed greenway to connect with Shug Jordan soccer fields and Westview Park (Porous Pavement)
- Incorporate GI BMPs for energy dissipation and water quality filtering of runoff from proposed parking areas, especially in steeper slope areas
- Potential BMPs include bioretention, stormwater swales, level spreaders, downspout planters, Porous pave pathways and runoff storage and reuse
- Project would require floodplain permitting for in-stream work

Site/BMP Characteristics	
Contributing Watershed (to BMPs only)	12.8 Acres
Impervious Area Managed	3.13 Acres
2-year 24-hour Design Storm	4.16 Inches
Volumetric Runoff Coefficient CN (varies by developed sub-watershed)	65.6 – 85.6
Projected Runoff Volume	489,244 Gallons
Preliminary Estimate of GI Construction Cost ($855,000 for Channel Restoration)	$1,353,398
Engineering & Construction Management	$270,640
Estimated Annual Operation & Maintenance ($2600 on channel establishment maintenance years 1-3)	$4,767 years 1-3 $2367 ongoing
Cost per square foot managed (Does not include Channel Restoration costs)	$0.89

Auburn Green Infrastructure Pilot Projects







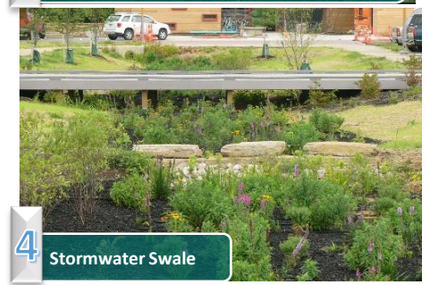
Creek Channel Restoration
Not to Scale

6 Level Spreaders dissipate stormwater runoff energy to protect from erosion

1 Porous Pave ADA compliant porous walkway

2 Creek Channel Restoration with native plantings

3 Planters intercept downspout runoff. Can be planted with herbs & vegetables for community food supply



4 Stormwater Swale

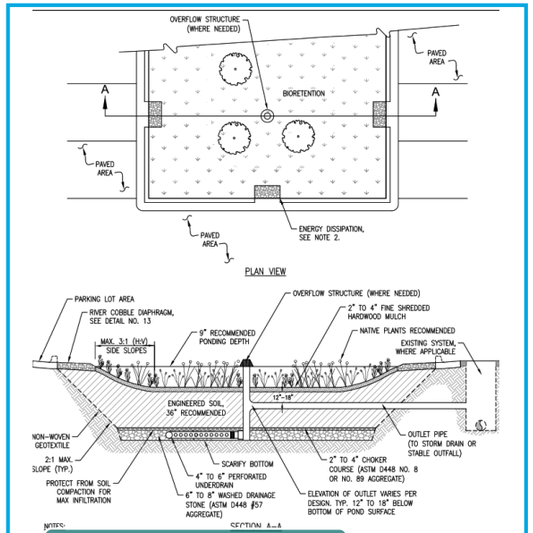
5 Bioretention basin on slope

City of Auburn

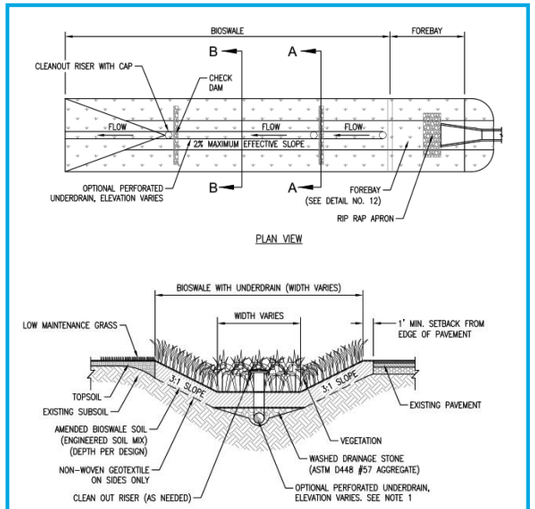
GI Pilot #26 Sam Harris Park
Costs & Details

GI Pilot #26 Sam Harris Park				
Preliminary Estimate of Probable GI Construction Cost - (01/2019)				
DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Project Sign	EA	1	$1,000.00	$1,000.00
12' wide Greenway Trail with Porous Pavement	LFT	2,200	$76.00	$167,200.00
Curb Turnout, Concrete	EA	10	$400.00	$4,000.00
Underdrains (6")-bioretention, level spreader, infiltration swale	LFT	2,360	$16.00	$37,760.00
Nyloplast 8" Overflow Inlet (at bioretention facilities)	EA	5	$750.00	$3,750.00
6" Underdrain Cleanout	EA	14	$300.00	$4,200.00
Creek Channel Resotration	LFT	2,850	$150.00	$427,500.00
Creek Bank Stabilization	SF	28,500	$15.00	$427,500.00
Level Spreader	LFT	810	$20.00	$16,200.00
StormGUARDen or similar premanufactured planter at bldg	EA	4	$2,000.00	$8,000.00
Bioretention Facility Excavation/Grading (2' below existing)	CYD	1,067	$10.00	$10,666.67
Bioretention Facility stone (1')	TON	936	$50.00	$46,800.00
Bioretention Facility soil (18")	CYD	800	$30.00	$24,000.00
Bioretention Facility Plants/shrubs (plugs or 1 Gal container)	EA	2,500	$15.00	$37,500.00
Stormwater Swale Grading (1050 ft)	CYD	1,244	$10.00	$12,444.44
Stormwater Swale Restoration - topsoil, seed, mulch	SYD	138	$12.00	$1,659.26
Item Total				$1,230,180.37
10% Contingency				$123,018.04
Total Estimate				**$1,353,198.41**
Engineering & CM (20%)				$270,639.68

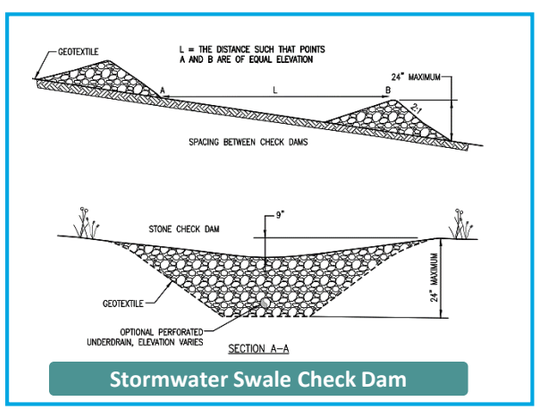
The preliminary cost estimate provided represents the anticipated conceptual cost of incorporating GI BMPs into the proposed project in lieu of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered to be part of the base project. Base project estimated costs for elements to be replaced with GI BMPs such as pavement, stormwater collection infrastructure, curb & gutter, detention, ditches, etc. can be deducted.



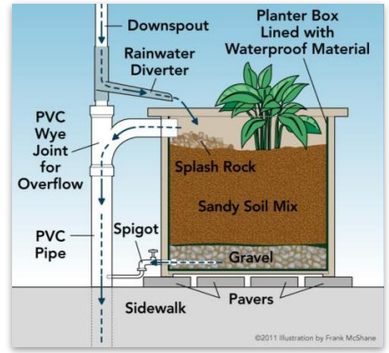
Bioretention Detail



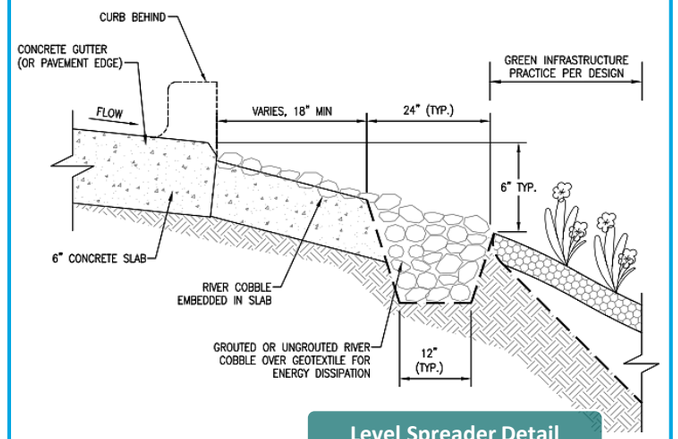
Stormwater Infiltration Swale Detail



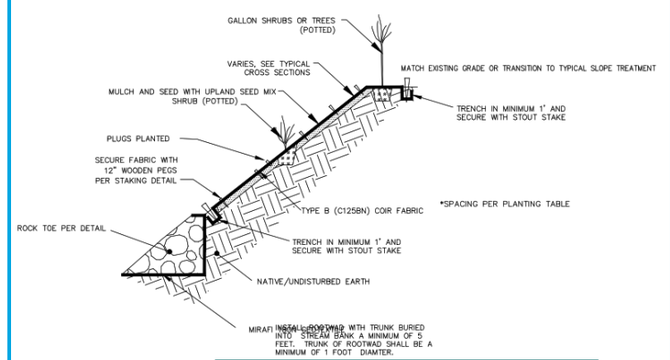
Stormwater Swale Check Dam



Downspout Planter Detail



Level Spreader Detail



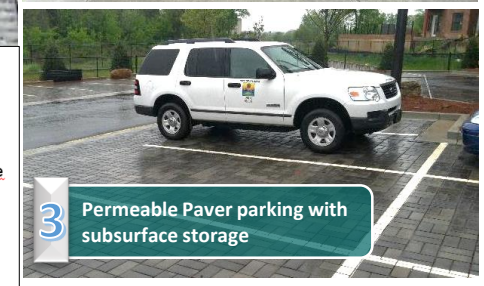
Creek Bank Stabilization Detail

City of Auburn

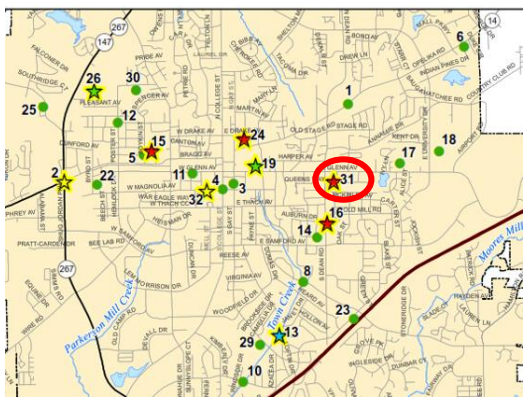
GI Pilot #31
Auburn Public Library

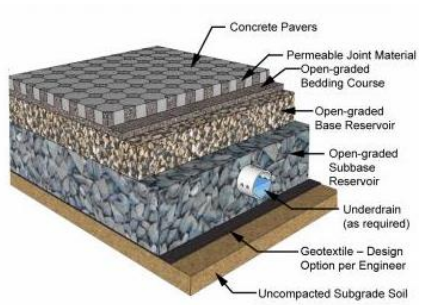
- Example for Site-Based 'Facility/Campus' GI Practices
- Public location affords educational opportunities
- Existing facility has extensive manicured landscaping
- Parking & drives are in very good condition
- Parking lot surface drainage pattern is conducive to capture and treat
- Potential BMPs include pervious parking bays, bioretention and use of greenspace for WQ swales
- Maintains existing parking counts
- Parking lot runoff management incorporated into new permeable pavement

Site/BMP Characteristics	
Contributing Watershed	0.86 Acres
Impervious Area Managed	0.74 Acres
2-Year 24-Hour Design Storm	4.16 Inches
Volumetric Runoff Coefficient CN	92.8
Projected Runoff Volume	78,267 Gallons
Preliminary Estimate of GI Construction Cost	$67,233
Engineering & Construction Management	$80,679
Estimated Annual Operation & Maintenance	$800
Cost per square foot managed	$1.80

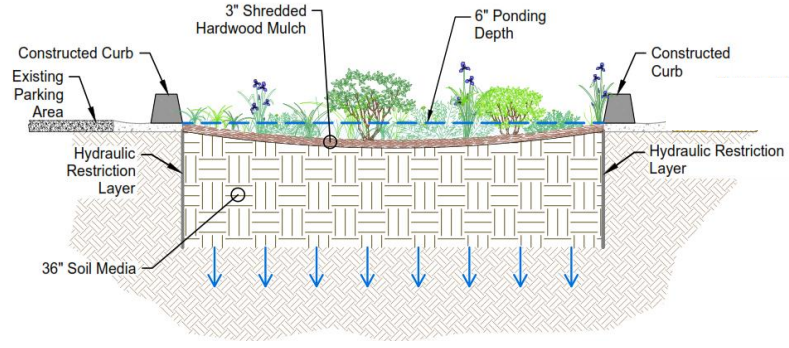


Auburn Green Infrastructure Pilot Projects

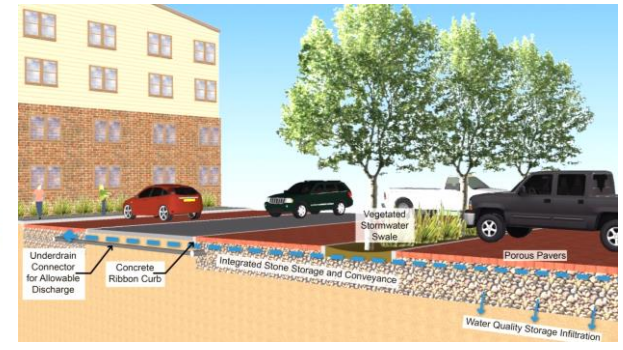




Permeable Paver Parking & Storage
Not to Scale



Parking Lot Bioretention Section
Not to Scale



City of Auburn

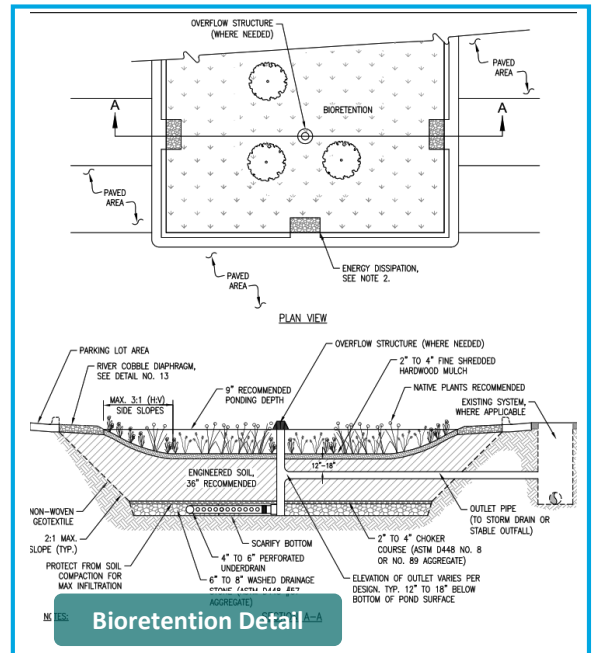
GI Pilot #31 Auburn Public Library Costs & Details

GI Pilot #31 Auburn Public Library

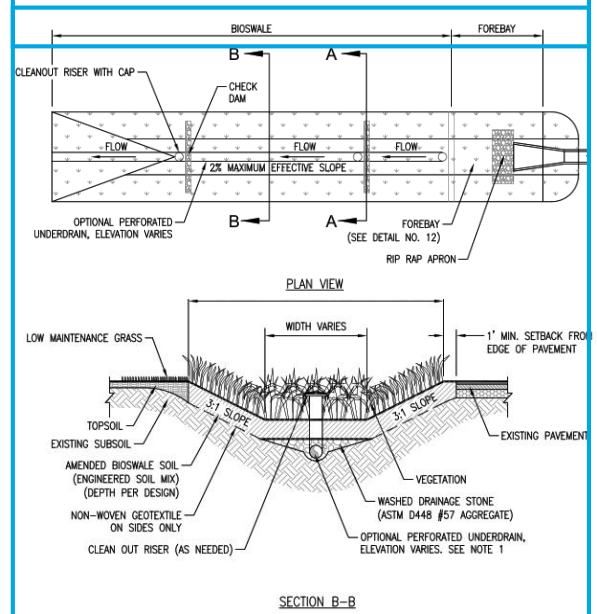
Preliminary Estimate of Probable Construction Cost - (01/2019)

DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Project Sign	EA	1	$600.00	$600.00
Saw Cut Asphalt	LFT	70	$8.00	$560.00
Pavement Removal, Asphalt	SYS	155	$16.00	$2,480.00
Saw Cut Curb Turnouts	EA	10	$120.00	$1,200.00
Excavation, Subgrade, For Stormwater Storage Cells	CYS	155	$15.00	$2,325.00
Coarse Aggregate 4" Stone Paver Base, Washed	TON	28	$17.00	$476.00
Coarse Aggregate 10" Washed for Standard Section	TON	76	$35.00	$2,654.17
Coarse Aggregate 3' Washed for Stormwater Storage	TON	273	$50.00	$13,650.00
Geotextile Separation Fabric	SYS	155	$5.50	$852.50
Porous Brick Pavers - parking	SYS	155	$45.00	$6,975.00
24" Combined Curb and Gutter, Concrete	LFT	110	$25.00	$2,750.00
Curb Turnout, Concrete	EA	8	$400.00	$3,200.00
Underdrains (6") - pavers, bioretention & infiltration swale	LFT	450	$14.00	$6,300.00
Connect to Existing Storm Manhole	EA	2	$800.00	$1,600.00
Storm Structure Modification	EA	1	$500.00	$500.00
Nyloplast 8" Overflow Inlet	EA	1	$750.00	$750.00
6" Underdrain Cleanout	EA	3	$300.00	$900.00
Bioretention Facility Excavation/Grading	CYD	353	$10.00	$3,525.93
Bioretention Facility soil	CYD	176	$30.00	$5,288.89
Bioretention Facility Plants/shrubs (1 Gal container)	EA	150	$15.00	$2,250.00
Infiltration Swale Grading	CYD	201	$10.00	$2,014.81
Infiltration Swale Restoration - topsoil, seed, mulch	SYD	22	$12.00	$268.64
Item Total				$61,120.94
10% Contingency				$6,112.09
Total Estimate				**$67,233.03**
Engineering & CM (20%)				$80,679.64

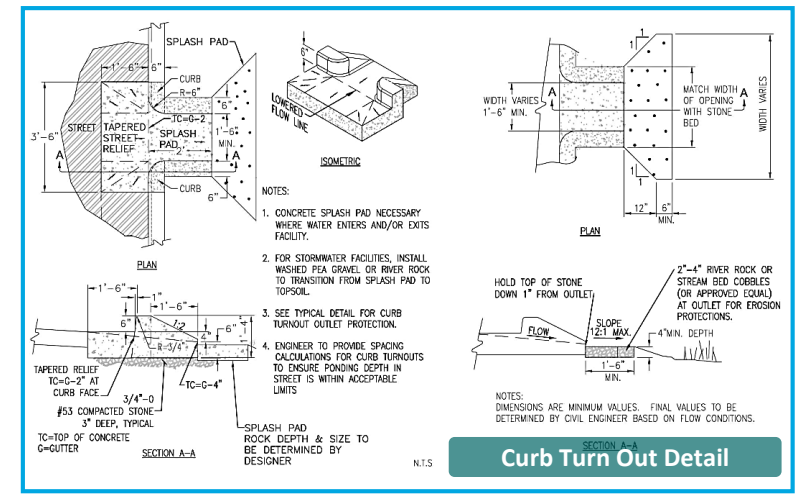
The preliminary cost estimate provided represents the anticipated conceptual cost of incorporating GI BMPs into the proposed project in lieu of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered to be part of the base project. Base project estimated costs for elements to be replaced with GI BMPs such as pavement, stormwater collection infrastructure, curb & gutter, detention, ditches, etc. can be deducted.



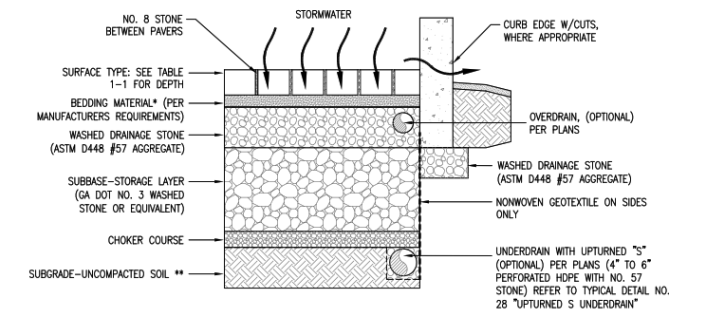
Bioretention Detail



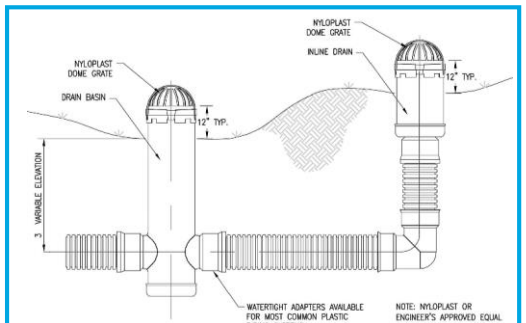
Stormwater/Infiltration Swale Detail



Curb Turn Out Detail



Permeable Pavement & Storage Section Detail



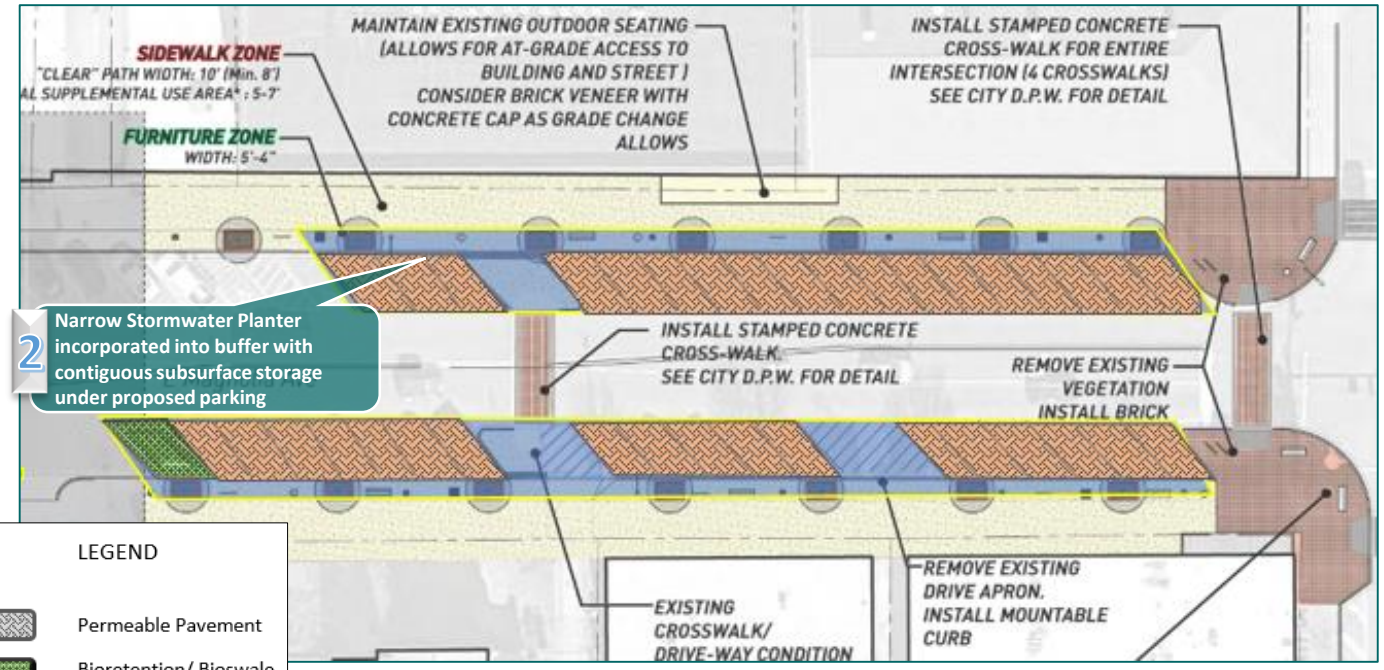
Bioretention Overflow Inlet Detail

City of Auburn

GI Pilot #32 East/West Magnolia

- Urban Streetscape retrofit – highly impervious
- GI Solutions need to blend with prior streetscape work
- Likely to include directly connected runoff contribution from rooftops outside of right-of-way resulting in City management of private runoff
- Permeable pavers can be tinted PaveDrain, or paver product
- Need to review proposed depth for potential conflicts with underground utilities. Depth and configuration of storage can be varied to avoid conflicts
- Possible use of pre-manufactured tree planters that provide additional or alternate storage option

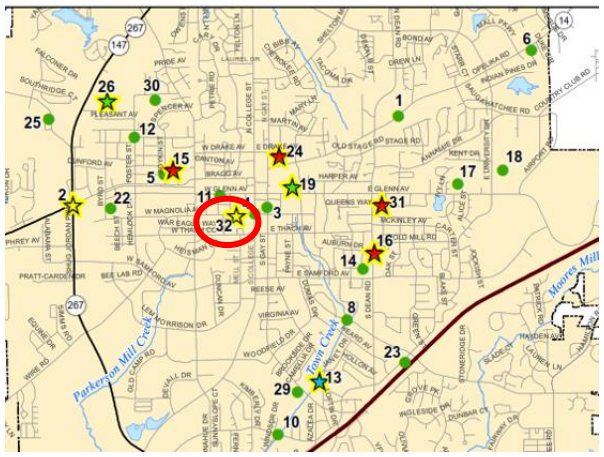
Site/BMP Characteristics	
Contributing Watershed	3.16 Acres
Impervious Area Managed	3.04 Acres
2-Year 24-Hour Design Storm	4.16 Inches
Volumetric Runoff Coefficient CN (varies by developed sub-watershed)	98 to 99.5
Projected Runoff Volume	327,161 gallons
Preliminary Estimate of GI Construction Cost	$800,500
Engineering & Construction Management	$200,125
Estimated Annual Operation & Maintenance	$1650
Cost per square foot managed (at 70% assumed capture – cost includes areas outside of ROW)	$7.27

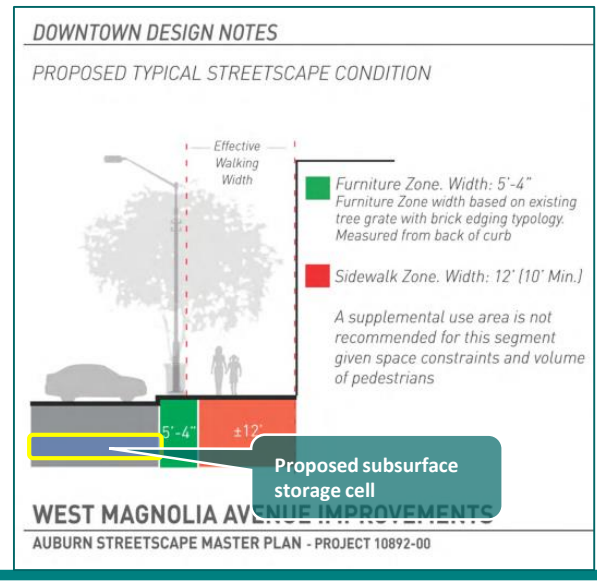


LEGEND

- Permeable Pavement
- Bioretention/ Bioswale
- Surface Drainage
- Existing Storm Inlet
- Existing Storm Pipe
- Existing storm MH
- Proposed Underdrain
- Subsurface Storage
- Sidewalk Trench Grate

Auburn Green Infrastructure Pilot Projects





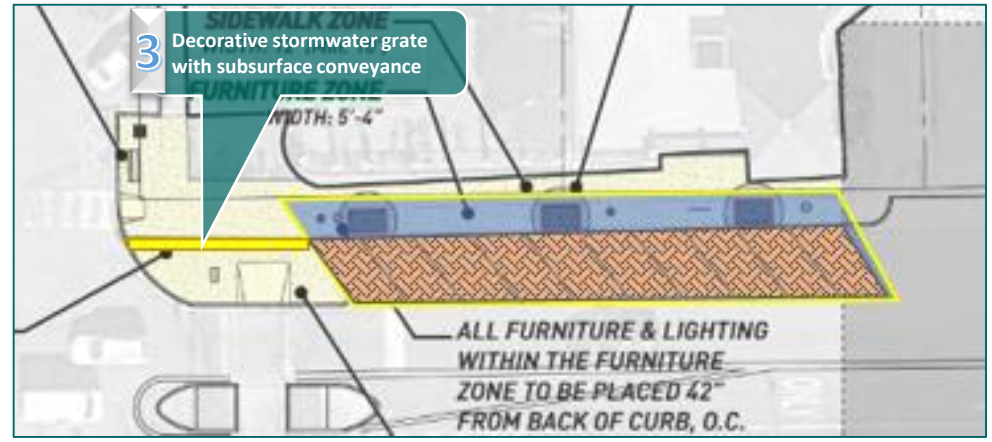
Stormwater Planter
Not to Scale

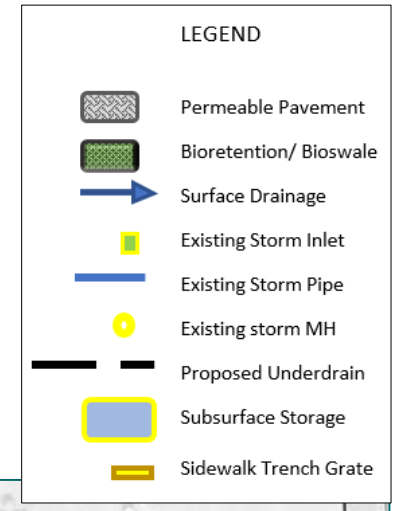
City of Auburn

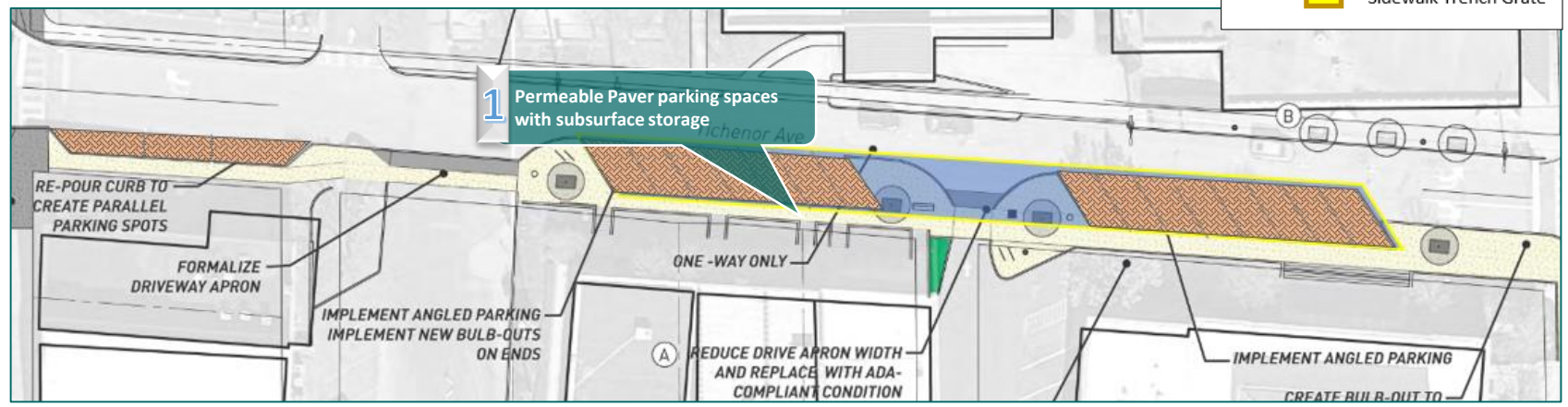
GI Pilot #32 East/West Magnolia

- Urban Streetscape retrofit – highly impervious
- GI Solutions need to blend with prior streetscape work
- Likely to include directly connected runoff contribution from rooftops outside of right-of-way resulting in City management of private runoff
- Permeable pavers can be tinted PaveDrain, or paver product
- Need to review proposed depth for potential conflicts with underground utilities. Depth and configuration of storage can be varied to avoid conflicts
- Possible use of pre-manufactured tree planters that provide additional or alternate storage option

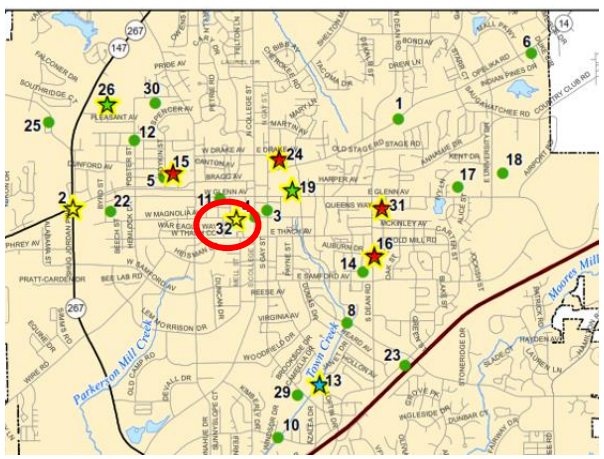
Site/BMP Characteristics	
Contributing Watershed	3.16 Acres
Impervious Area Managed	3.04 Acres
2-Year 24-Hour Design Storm	4.16 Inches
Volumetric Runoff Coefficient CN (varies by developed sub-watershed)	98 to 99.5
Projected Runoff Volume	327,161 gallons
Preliminary Estimate of GI Construction Cost	$800,500
Engineering & Construction Management	$200,125
Estimated Annual Operation & Maintenance	$1650
Cost per square foot managed (at 70% assumed capture – cost includes areas outside of ROW)	$7.27

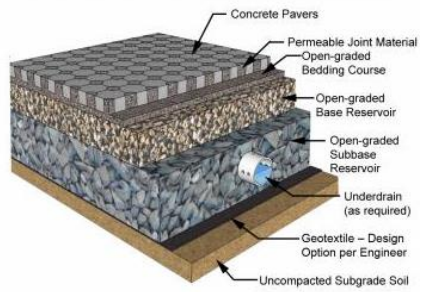






Auburn Green Infrastructure Pilot Projects





Permeable Paver Parking & Storage
Not to Scale

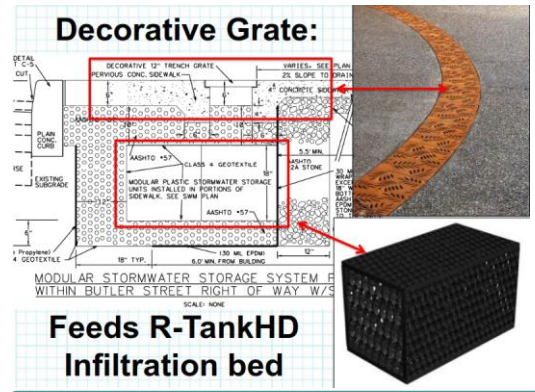
City of Auburn

GI Pilot #32 East/West Magnolia
GI Costs & Details

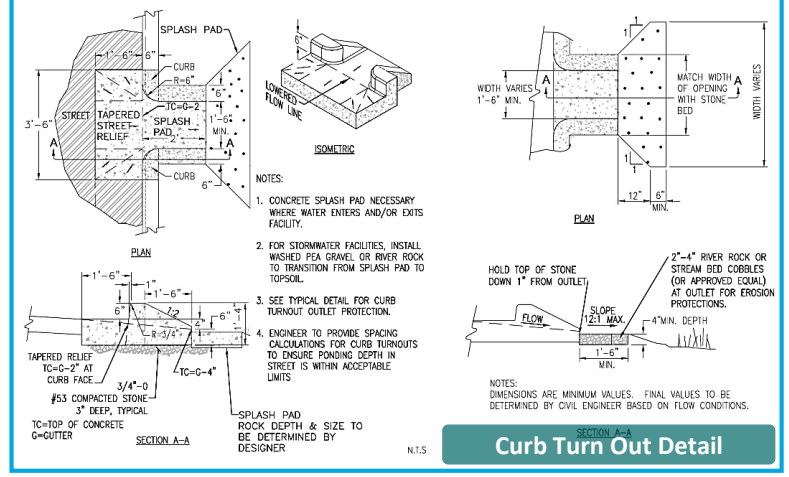
GI Pilot #32 East-West Magnolia

Preliminary Estimate of Probable Construction Cost - (01/2019)

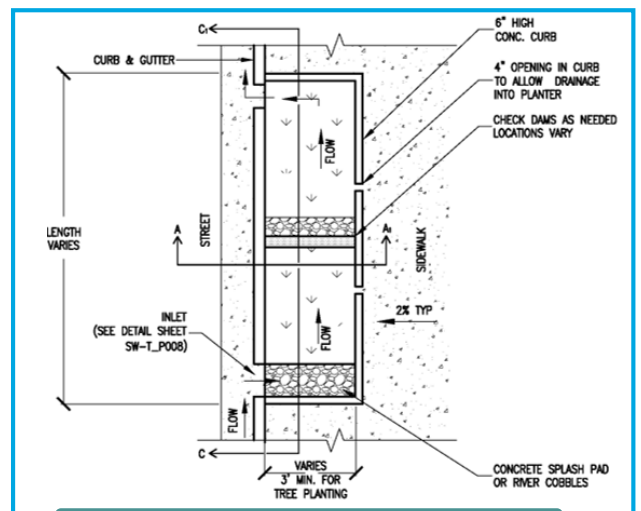
GI BMP ELEMENT DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Excavation, Subgrade, for Stormwater Storage Cells	CYS	1,158	$15.00	$17,366.67
Coarse Aggregate 4" Stone Paver Base, Washed	TON	625	$17.00	$10,628.40
Coarse Aggregate 10" Washed for Standard Section	TON	1,693	$30.00	$50,797.50
Coarse AggregateWashed 3' for Stormwater Storage	TON	6,096	$30.00	$182,871.00
Geotextile Separation Fabric	SYS	5,210	$4.50	$23,445.00
Porous Brick Pavers - Parking	SYS	3,473	$45.00	$156,300.00
Curb Turnout, Concrete	EA	36	$500.00	$18,000.00
Underdrains 6" Pipe	LFT	925	$12.00	$11,100.00
Sidewalk Trench Drain	EA	1	$3,000.00	$3,000.00
Connect to Existing Storm Manhole	EA	4	$1,000.00	$4,000.00
Storm Structure Modification	EA	4	$500.00	$2,000.00
6" Dual Wall HDPE Storm Pipe	LFT	100	$26.00	$2,600.00
Nyloplast 8" Overflow Inlet	EA	1	$750.00	$750.00
6" Stormwater Cleanout	EA	4	$300.00	$1,200.00
RTank or similar premanufactured storage under Bocce & adjacent	CFT	39,090	$6.00	$234,540.00
Stormwater Planter Excavation/Grading (4' below existing)	CYD	119	$15.00	$1,777.78
Stormwater Planter stone (2')	TON	104	$50.00	$5,200.00
Stormwater Planter soil (18')	CYD	44	$30.00	$1,333.33
Stormwater Planter Plants/shrubs (1 Gal container)	EA	8	$35.00	$280.00
Stormwater Planter Plant Plugs	EA	20	$12.00	$240.00
Planter Mulch 4"	CYD	10	$30.00	$296.30
Item Total				$727,725.97
10% Contingency				$72,772.60
Total GI BMP Estimate				**$800,498.57**
Engineering & CM 25%				$200,124.64



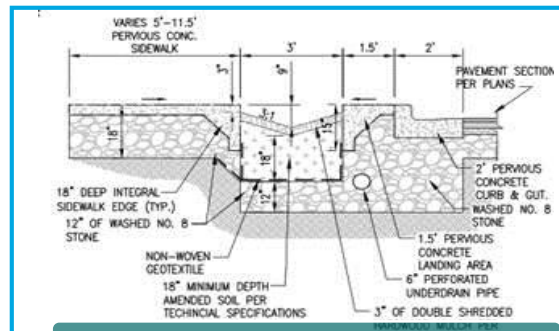
Decorative Grate with Subsurface Storage



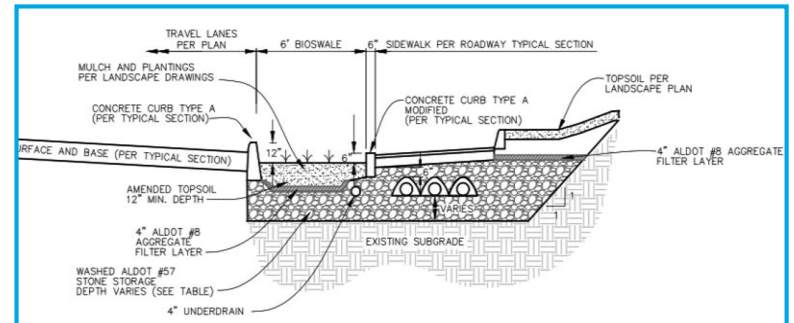
Curb Turn Out Detail



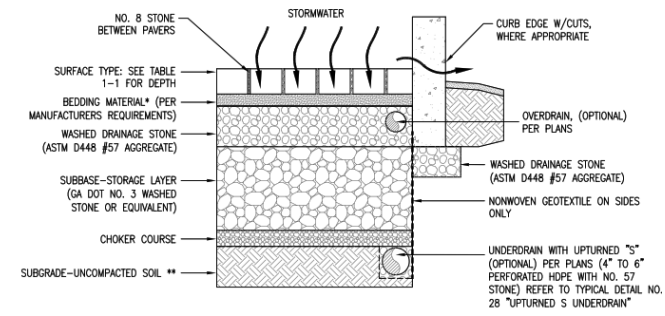
Stormwater Planter Plan Detail



Narrow Stormwater Planter Detail



Stormwater Planter with Storage Detail



Permeable Pavement & Storage Section Detail

The preliminary cost estimate provided represents the anticipated conceptual cost of incorporating GI BMPs into the proposed project in lieu of traditional stormwater collection, conveyance, and storage elements. Project costs such as mobilization, clearing, and proposed street, sidewalk, and utility improvements are considered to be part of the base project. Base project estimated costs for elements to be replaced with GI BMPs such as pavement, stormwater collection infrastructure, curb & gutter, detention, ditches, etc. can be deducted.

City of Auburn

Appendix B
Green Infrastructure
Pilot Project Cost Estimates

GI Pilot #2 MLK Drive GI Practices

Preliminary Estimate of Probable Construction Cost - (01/2019)

GI BMP ELEMENT DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Excavation, Subgrade, for Stormwater Storage Cells	CYS	497	$15.00	$7,458.33
Coarse Aggregate Stone Paver Base, Washed	TON	269	$17.00	$4,564.50
Coarse Aggregate Washed for Standard Section	TON	727	$30.00	$21,815.63
Coarse AggregateWashed for Stormwater Storage	TON	1,745	$30.00	$52,357.50
Geotextile Separation Fabric	SYS	2,238	$4.50	$10,068.75
3' PaveDrain Shoulder	SYS	1,492	$90.00	$134,250.00
Curb, Concrete Barrier, at Stormwater Planters	LFT	7,200	$12.00	$86,400.00
Curb Turnout, Concrete	EA	36	$500.00	$18,000.00
Underdrains 6" Pipe	LFT	15,560	$12.00	$186,720.00
Sidewalk Trench Drain	EA	8	$900.00	$7,200.00
Connect to Existing Storm Manhole	EA	8	$1,000.00	$8,000.00
Storm Structure Modification	EA	4	$500.00	$2,000.00
6" Dual Wall HDPE Storm Pipe	LFT	1,000	$26.00	$26,000.00
Nyloplast 8" Overflow Inlet	EA	14	$750.00	$10,500.00
6" Stormwater Cleanout	EA	14	$300.00	$4,200.00
Stormwater Planter Excavation/Grading (3' below existing)	CYD	3,733	$15.00	$56,000.00
Stormwater Planter stone (2')	TON	6,552	$50.00	$327,600.00
Stormwater Planter soil (18')	CYD	1,400	$30.00	$42,000.00
Stormwater Planter Plants/shrubs (1 Gal container)	EA	1,000	$35.00	$35,000.00
Stormwater Planter Plant Plugs	EA	8,000	$12.00	$96,000.00
Stormwater Swale Grading (7485 ft)	CYD	8,871	$10.00	$88,711.11
Stormwater Swale Restoration - topsoil, seed, mulch	SYD	6,653	$12.00	$79,840.00
Planter Mulch 4"	CYD	311	$30.00	$9,333.33
Item Total				$1,314,019.15
10% Contingency				$131,401.92
Total GI BMP Estimate				**$1,445,421.07**
Engineering & CM 25%				$361,355.27
Annual Maintenance Cost Assumptions				
PaveDrain @$1000 per sweeping - every other year	$500			
Swales $1400 per year @ $1475/acre	$1,400			
Planters 1/2 acre @ $1475 per acre	$750			
	$2,650			

GI Pilot #13 Town Creek Park

Preliminary Estimate of Probable GI Construction Cost - (01/2019)

DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Project Sign	EA	1	$1,000.00	$1,000.00
Coarse Aggregate 10" Washed for Standard Section	TON	650	$35.00	$22,750.00
Geotextile Separation Fabric	SYS	1,333	$4.50	$6,000.00
PaveDrain Walkway	SYS	1,333	$45.00	$60,000.00
Curb Turnout, Concrete	EA	4	$400.00	$1,600.00
Underdrains (6") - stormwater swale	LFT	900	$16.00	$14,400.00
Connect to Existing Storm Manhole	EA	2	$800.00	$1,600.00
Nyloplast 8" Overflow Inlet	EA	3	$750.00	$2,250.00
6" Underdrain Cleanout	EA	4	$300.00	$1,200.00
Creek Channel Resotration	LFT	2,300	$150.00	$345,000.00
Creek Bank Stabilization	SF	9,000	$15.00	$135,000.00
Sidewalk Trench Drain	EA	2	$1,100.00	$2,200.00
Bioretention Facility Excavation/Grading (2' below existing)	CYD	1,415	$10.00	$14,148.15
Bioretention Facility stone (12")	TON	1,242	$50.00	$62,075.00
Bioretention Facility soil (18")	CYD	1,061	$30.00	$31,833.33
Bioretention Facility Plants/shrubs (plugs or 1 Gal container)	EA	2,000	$15.00	$30,000.00
Stormwater Swale Grading (1000 ft)	CYD	1,185	$10.00	$11,851.85
Stormwater Swale Restoration - topsoil, seed, mulch	SYD	132	$12.00	$1,580.25
Item Total				$744,488.58
10% Contingency				$74,448.86
Total Estimate				**$818,937.44**
Engineering & CM (20%)				$163,787.49

Annual Maintenance Cost Assumptions		
Channel restoration (years 1-3 establishment)	$2,600	Use $200/year post establishment. Year 1-3 costs can be built into contract.
0.2-acre Swales @ $1475 per acre	$295	
Bioretention 0.24 acre @ $1475 per acre	$354	
PaveDrain @$1000 per sweeping - every other year	$500	
	$3,749	

GI Pilot #15 Boykin/Donahue Campus

Preliminary Estimate of Probable GI Construction Cost - (01/2019)

DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Project Sign	EA	1	$1,000.00	$1,000.00
Excavation, Subgrade, for Stormwater Storage Cells	CYS	4,000	$10.00	$40,000.00
Coarse Aggregate 4" Stone Paver Base, Washed	TON	640	$17.00	$10,880.00
Coarse Aggregate 10" Washed for Standard Section	TON	1,733	$35.00	$60,666.67
Coarse Aggregate 2' Washed for Stormwater Storage	TON	4,160	$50.00	$208,000.00
Geotextile Separation Fabric	SYS	3,556	$4.50	$16,000.00
Porous Brick Pavers - parking	SYS	3,556	$45.00	$160,000.00
Curb Turnout, Concrete	EA	10	$400.00	$4,000.00
Underdrains (6") - pavers & infiltration swale	LFT	3,000	$16.00	$48,000.00
8" Dual Wall HDPE storm pipe	LFT	1,000	$35.00	$35,000.00
Connect to Existing Storm Manhole	EA	2	$800.00	$1,600.00
Nyloplast 8" Overflow Inlet	EA	4	$750.00	$3,000.00
6" Underdrain Cleanout	EA	20	$300.00	$6,000.00
StormGUARDen or similar premanufactured planter at bldg	EA	10	$2,000.00	$20,000.00
RTank or similar premanufactured storage under play fields	CFT	12,000	$6.00	$72,000.00
Rainwater Harvest & Reuse system (complete)	ALLOW	1	$80,000.00	$80,000.00
Stormwater Swale Grading (1000 ft)	CYD	1,185	$10.00	$11,851.85
Stormwater Swale Restoration - topsoil, seed, mulch	SYD	132	$12.00	$1,580.25
Item Total				$779,578.77
10% Contingency				$77,957.88
Total Estimate				**$857,536.64**
Engineering & CM (20%)				$171,507.33

Annual Maintenance Cost Assumptions		
0.7-acre PaveDrain @$1000 per sweeping - every other year	$500	note only .73 acres but assuming
Swales $1475/acre/year - 0.2 acres	$295	minimum cost for mobilization, etc.
Planters 10 @ $1475 per acre	$750	
Subsurface Rtank reuse system & controls	$1,000	
	$2,545	

GI Pilot #16 Dean Road Recreation Center

Preliminary Estimate of Probable GI Construction Cost - (01/2019)

DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Project Sign	EA	1	$1,000.00	$1,000.00
Excavation, Subgrade, for Stormwater Storage Cells	CYS	2,311	$15.00	$34,666.67
Coarse Aggregate 4" Stone Paver Base, Washed	TON	312	$17.00	$5,304.00
Coarse Aggregate 10" Washed for Standard Section	TON	845	$35.00	$29,575.00
Coarse Aggregate 2' Washed for Stormwater Storage	TON	2,028	$50.00	$101,400.00
Geotextile Separation Fabric	SYS	1,733	$4.50	$7,800.00
Porous Brick Pavers - parking	SYS	1,733	$45.00	$78,000.00
Curb Turnout, Concrete	EA	4	$400.00	$1,600.00
Underdrains (6") - pavers, level spreader & infiltration swale	LFT	1,590	$16.00	$25,440.00
Connect to Existing Storm Manhole	EA	2	$800.00	$1,600.00
Nyloplast 8" Overflow Inlet	EA	4	$750.00	$3,000.00
6" Underdrain Cleanout	EA	12	$300.00	$3,600.00
Creek Channel Resotration	LFT	400	$150.00	$60,000.00
Creek Bank Stabilization	SF	4,000	$15.00	$60,000.00
Level Spreader	LFT	200	$20.00	$4,000.00
Bioretention Facility Excavation/Grading (2' below existing)	CYD	843	$10.00	$8,425.93
Bioretention Facility stone (12")	TON	59	$50.00	$2,957.50
Bioretention Facility soil (18")	CYD	506	$30.00	$15,166.67
Bioretention Facility Plants/shrubs (plugs or 1 Gal container)	EA	1,000	$15.00	$15,000.00
Stormwater Swale Grading (420 ft)	CYD	498	$10.00	$4,977.78
Stormwater Swale Restoration - topsoil, seed, mulch	SYD	55	$12.00	$663.70
Item Total				$464,177.24
10% Contingency				$46,417.72
Total Estimate				**$510,594.96**
Engineering & CM (20%)				$102,118.99

Annual Maintenance Cost Assumptions	
400' channel restoration (years 1-3 establishment)	$800
0.08-acre Swales @ $1475 per acre	$118
Bioretention 0.21 acre @ $1475 per acre	$310
PaveDrain @$1000 per sweeping - every other year	$500
Level spreader clean out	$300
	$2,028

GI Pilot #19 Felton Little Park

Preliminary Estimate of Probable GI Construction Cost - (01/2019)

DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Project Sign	EA	1	$1,000.00	$1,000.00
Excavation, Subgrade, for Stormwater Storage Cells	CYS	1,904	$15.00	$28,555.56
Coarse Aggregate 4" Stone Paver Base, Washed	TON	236	$17.00	$4,012.00
Coarse Aggregate 10" Washed for Standard Section	TON	639	$35.00	$22,370.83
Coarse Aggregate 2' Washed for Stormwater Storage	TON	2,301	$50.00	$115,050.00
Geotextile Separation Fabric	SYS	1,311	$4.50	$5,900.00
Porous Brick Pavers - parking	SYS	1,311	$45.00	$59,000.00
Curb Turnout, Concrete	EA	2	$400.00	$800.00
Underdrains (6") - pavers & infiltration swale	LFT	2,000	$16.00	$32,000.00
8" Dual Wall HDPE storm pipe	LFT	600	$35.00	$21,000.00
Connect to Existing Storm Manhole	EA	1	$800.00	$800.00
Nyloplast 8" Overflow Inlet	EA	1	$750.00	$750.00
6" Underdrain Cleanout	EA	4	$300.00	$1,200.00
StormGUARDen or similar premanufactured planter at bldg	EA	4	$2,000.00	$8,000.00
RTank or similar premanufactured storage under play fields	CFT	16,000	$6.00	$96,000.00
Rainwater Harvest & Reuse system (complete)	ALLOW	1	$80,000.00	$80,000.00
Stormwater Swale Grading (1000 ft)	CYD	1,185	$10.00	$11,851.85
Stormwater Swale Restoration - topsoil, seed, mulch	SYD	132	$12.00	$1,580.25
Item Total				$489,870.49
10% Contingency				$48,987.05
Total Estimate				**$538,857.54**
Engineering & CM (20%)				$107,771.51

Annual Maintenance Cost Assumptions		
0.7-acre PaveDrain @$1000 per sweeping - every other year	$500	note only .73 acres but assuming
Swales $1475/acre/year - 0.2 acres	$295	minimum cost for mobilization, etc.
Planters 4 @ $1475 per acre	$750	
Subsurface Rtank reuse system & controls	$1,000	
	$2,545	

GI Pilot #21 Lake Wilmore Park

Preliminary Estimate of Probable GI Construction Cost - (01/2019)

DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Project Sign	EA	1	$1,000.00	$1,000.00
Excavation, Subgrade, for Stormwater Storage Cells	CYS	3,644	$10.00	$36,444.44
Coarse Aggregate 4" Stone Paver Base, Washed	TON	656	$17.00	$11,152.00
Coarse Aggregate 10" Washed for Standard Section	TON	1,777	$35.00	$62,183.33
Coarse Aggregate 2' Washed for Stormwater Storage	TON	4,264	$50.00	$213,200.00
Geotextile Separation Fabric	SYS	3,644	$4.50	$16,400.00
Porous Brick Pavers - parking	SYS	3,644	$45.00	$164,000.00
Curb Turnout, Concrete	EA	25	$400.00	$10,000.00
Underdrains (6") - pavers & infiltration swale	LFT	5,500	$16.00	$88,000.00
Nyloplast 8" Overflow Inlet	EA	12	$750.00	$9,000.00
6" Underdrain Cleanout	EA	20	$300.00	$6,000.00
Rainwater Harvest & Reuse system (complete)	ALLOW	1	$80,000.00	$80,000.00
RTank or similar premanufactured storage	CFT	88,000	$6.00	$528,000.00
Bioretention Facility Excavation/Grading (3' below existing)	CYD	11,897	$10.00	$118,966.67
Bioretention Facility stone (12")	TON	6,960	$50.00	$347,977.50
Bioretention Facility soil (18')	CYD	5,948	$30.00	$178,450.00
Bioretention Facility Plants/shrubs (plugs or 1 Gal container)	EA	11,000	$15.00	$165,000.00
Stormwater Swale Grading (3400 ft)	CYD	4,030	$10.00	$40,296.30
Stormwater Swale Restoration - topsoil, seed, mulch	SYD	448	$12.00	$5,372.84
Item Total				$2,081,443.08
10% Contingency				$208,144.31
Total Estimate				**$2,289,587.39**
Engineering & CM (20%)				$457,917.48

Annual Maintenance Cost Assumptions	
0.75-acre PaveDrain @$1000 per sweeping - every other year	$500
Swales $1475/acre/year - 0.62 acres	$915
2.4 acres bioretention @ $1475/acre	$3,540
Subsurface Rtank reuse system & controls	$1,000
	$5,955

GI Pilot #24 Parks & Recreation Main Campus

Preliminary Estimate of Probable GI Construction Cost - (01/2019)

DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Project Sign	EA	1	$1,000.00	$1,000.00
Excavation, Subgrade, for Stormwater Storage Cells	CYS	822	$15.00	$12,333.33
Coarse Aggregate 4" Stone Paver Base, Washed	TON	148	$17.00	$2,516.00
Coarse Aggregate 10" Washed for Standard Section	TON	401	$35.00	$14,029.17
Coarse Aggregate 3' Washed for Stormwater Storage	TON	1,443	$50.00	$72,150.00
Geotextile Separation Fabric	SYS	822	$4.50	$3,700.00
Porous Brick Pavers - parking	SYS	822	$45.00	$37,000.00
Curb Turnout, Concrete	EA	2	$400.00	$800.00
Underdrains (6") - pavers & infiltration swale	LFT	400	$16.00	$6,400.00
Connect to Existing Storm Manhole	EA	2	$800.00	$1,600.00
Nyloplast 8" Overflow Inlet	EA	2	$750.00	$1,500.00
6" Underdrain Cleanout	EA	4	$300.00	$1,200.00
StormGUARDen or similar premanufactured planter at bldg	EA	2	$2,000.00	$4,000.00
RTank or similar premanufactured storage under Bocce & adjacent	CFT	16,000	$6.00	$96,000.00
Bioretention Facility Excavation/Grading (2' below existing)	CYD	867	$10.00	$8,666.67
Bioretention Facility stone (1.5')	TON	1,121	$50.00	$56,062.50
Bioretention Facility soil (2.5')	CYD	1,065	$30.00	$31,944.44
Bioretention Facility Plants/shrubs (plugs or 1 Gal container)	EA	750	$15.00	$11,250.00
Stormwater Swale Grading (200 ft)	CYD	237	$10.00	$2,370.37
Stormwater Swale Restoration - topsoil, seed, mulch	SYD	26	$12.00	$316.05
Item Total				$364,838.53
10% Contingency				$36,483.85
Total Estimate				**$401,322.38**
Engineering & CM (20%)				$80,264.48

Annual Maintenance Cost Assumptions	
Subsurface storage annual maintenance	$500
0.08-acre Swales @ $1475 per acre	$118
Bioretention 0.26 acre @ $1475 per acre	$384
PaveDrain @$1000 per sweeping - every other year	$500
	$1,502

GI Pilot #26 Sam Harris Park

Preliminary Estimate of Probable GI Construction Cost - (01/2019)

DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Project Sign	EA	1	$1,000.00	$1,000.00
12' wide Greenway Trail with Porous Pavement	LFT	2,200	$76.00	$167,200.00
Curb Turnout, Concrete	EA	10	$400.00	$4,000.00
Underdrains (6")-bioretention, level spreader, infiltration swale	LFT	2,360	$16.00	$37,760.00
Nyloplast 8" Overflow Inlet (at bioretention facilities)	EA	5	$750.00	$3,750.00
6" Underdrain Cleanout	EA	14	$300.00	$4,200.00
Creek Channel Resotration	LFT	2,850	$150.00	$427,500.00
Creek Bank Stabilization	SF	28,500	$15.00	$427,500.00
Level Spreader	LFT	810	$20.00	$16,200.00
StormGUARDen or similar premanufactured planter at bldg	EA	4	$2,000.00	$8,000.00
Bioretention Facility Excavation/Grading (2' below existing)	CYD	1,067	$10.00	$10,666.67
Bioretention Facility stone (1')	TON	936	$50.00	$46,800.00
Bioretention Facility soil (18")	CYD	800	$30.00	$24,000.00
Bioretention Facility Plants/shrubs (plugs or 1 Gal container)	EA	2,500	$15.00	$37,500.00
Stormwater Swale Grading (1050 ft)	CYD	1,244	$10.00	$12,444.44
Stormwater Swale Restoration - topsoil, seed, mulch	SYD	138	$12.00	$1,659.26
Item Total				$1,230,180.37
10% Contingency				$123,018.04
Total Estimate				**$1,353,198.41**
Engineering & CM (20%)				$270,639.68

Annual Maintenance Cost Assumptions		
Channel restoration (years 1-3 establishment)	$2,600	Use $200/year post-establishment.
0.2-acre Swales @ $1475 per acre	$295	Year 1-3 costs can be built into contract.
Bioretention 0.34 acre @ $1475 per acre	$502	
Planters 4 @ $1475 per acre	$750	
Level Spreaders - 1 cleaning/year	$500	
	$4,647	

GI Pilot #31 Coa Library

Preliminary Estimate of Probable Construction Cost - (01/2019)

DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Project Sign	EA	1	$600.00	$600.00
Saw Cut Asphalt	LFT	70	$8.00	$560.00
Pavement Removal, Asphalt	SYS	155	$16.00	$2,480.00
Saw Cut Curb Turnouts	EA	10	$120.00	$1,200.00
Excavation, Subgrade, for Stormwater Storage Cells	CYS	155	$15.00	$2,325.00
Coarse Aggregate 4" Stone Paver Base, Washed	TON	28	$17.00	$476.00
Coarse Aggregate 10" Washed for Standard Section	TON	76	$35.00	$2,654.17
Coarse Aggregate 3' Washed for Stormwater Storage	TON	273	$50.00	$13,650.00
Geotextile Separation Fabric	SYS	155	$5.50	$852.50
Porous Brick Pavers - parking	SYS	155	$45.00	$6,975.00
24" Combined Curb and Gutter, Concrete	LFT	110	$25.00	$2,750.00
Curb Turnout, Concrete	EA	8	$400.00	$3,200.00
Underdrains (6") - pavers, bioretention & infiltration swale	LFT	450	$14.00	$6,300.00
Connect to Existing Storm Manhole	EA	2	$800.00	$1,600.00
Storm Structure Modification	EA	1	$500.00	$500.00
Nyloplast 8" Overflow Inlet	EA	1	$750.00	$750.00
6" Underdrain Cleanout	EA	3	$300.00	$900.00
Bioretention Facility Excavation/Grading	CYD	353	$10.00	$3,525.93
Bioretention Facility soil	CYD	176	$30.00	$5,288.89
Bioretention Facility Plants/shrubs (1 Gal container)	EA	150	$15.00	$2,250.00
Infiltration Swale Grading	CYD	201	$10.00	$2,014.81
Infiltration Swale Restoration - topsoil, seed, mulch	SYD	22	$12.00	$268.64
Item Total				$61,120.94
10% Contingency				$6,112.09
Total Estimate				**$67,233.03**
Engineering & CM (20%)				$80,679.64

Annual Maintenance Cost Assumptions	
0.03-acre Swales @ $1475 per acre (use $150 min.)	$150
Bioretention 0.055 acre @ $1475 per acre (use $150 min.)	$150
PaveDrain @$1000 per sweeping - every other year	$500
	$800

GI Pilot #32 East-West Magnolia

ary Estimate of Probable Construction Cost - (01/2019)

GI BMP ELEMENT DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL PRICE FOR ITEM
Excavation, Subgrade, for Stormwater Storage Cells	CYS	1,158	$15.00	$17,366.67
Coarse Aggregate 4" Stone Paver Base, Washed	TON	625	$17.00	$10,628.40
Coarse Aggregate 10" Washed for Standard Section	TON	1,693	$30.00	$50,797.50
Coarse AggregateWashed 3' for Stormwater Storage	TON	6,096	$30.00	$182,871.00
Geotextile Separation Fabric	SYS	5,210	$4.50	$23,445.00
Porous Brick Pavers - Parking	SYS	3,473	$45.00	$156,300.00
Curb Turnout, Concrete	EA	36	$500.00	$18,000.00
Underdrains 6" Pipe	LFT	925	$12.00	$11,100.00
Sidewalk Trench Drain	EA	1	$3,000.00	$3,000.00
Connect to Existing Storm Manhole	EA	4	$1,000.00	$4,000.00
Storm Structure Modification	EA	4	$500.00	$2,000.00
6" Dual Wall HDPE Storm Pipe	LFT	100	$26.00	$2,600.00
Nyloplast 8" Overflow Inlet	EA	1	$750.00	$750.00
6" Stormwater Cleanout	EA	4	$300.00	$1,200.00
RTank or similar premanufactured storage under Bocce & adjacent	CFT	39,090	$6.00	$234,540.00
Stormwater Planter Excavation/Grading (4' below existing)	CYD	119	$15.00	$1,777.78
Stormwater Planter stone (2')	TON	104	$50.00	$5,200.00
Stormwater Planter soil (18')	CYD	44	$30.00	$1,333.33
Stormwater Planter Plants/shrubs (1 Gal container)	EA	8	$35.00	$280.00
Stormwater Planter Plant Plugs	EA	20	$12.00	$240.00
Planter Mulch 4"	CYD	10	$30.00	$296.30
Item Total				$727,725.97
10% Contingency				$72,772.60
Total GI BMP Estimate				**$800,498.57**
Engineering & CM 25%				$200,124.64
Annual Maintenance Cost Assumptions				
PaveDrain @$1000 per sweeping - every year	$1,000			
Subsurface storage and trench grate inspection/cleaning	$500			
Planters -.1 acre @ $1475 per acre	$150			
	$1,650			

Appendix C
Operation and Maintenance Guidance and Checklists

Estimated Operation and Maintenance Cost

The City of Auburn is committed to providing a good example and showcasing effective publicly-owned BMPs through the 10 identified pilot projects to developers and property owners who inspect and maintain BMPs of their own. A properly functioning BMP provides for the prevention of flooding, erosion and pollution that can be caused by stormwater and adds an aesthetic value to the community. Regular inspection and maintenance to keep BMPs functioning as they were designed is critical and must be budgeted early in the planning process. If a BMP is not functioning properly, homes and property can be damaged, roadways and sidewalks can flood, streams and aquatic life can be threatened, and human health can be affected.

There are five components that are common to all BMPs that are utilized in the 10 identified pilot projects. These five common components are labeled in Figures 1 and 2 and the necessary inspection and maintenance activities are described below:

1. **Inlet structures** bring water into the BMP. They should be free of sediment, trash, and debris. Erosion, scour, and damage should be evaluated and addressed.
2. **Pretreatment** is the first layer of protection for the main treatment area. Debris and coarse sediment are removed in the pretreatment area, and this reduces clogging in the main treatment area. The pretreatment area can be cleaned more easily than the main treatment area. It should be free of sediment, trash, and debris. Erosion, scour, and damage should be evaluated and addressed.
3. **Main treatment** is where stormwater is collected so that water can be discharged at a controlled rate. These areas should be free from trash and overgrown vegetation and inspected for sediment and signs of erosion. The time it takes for stormwater to infiltrate or exit the BMP should be regularly checked to ensure it is consistent with the design of the BMP. Issues with ponding, dry conditions, and/or outflow at unexpected times may need to be addressed.
4. **Emergency overflow** is designed to keep the area surrounding the BMP from flooding in very large rain events. Similar to outlets, spillways need to be kept clear to prevent flooding. Erosion, scour, and damage should be evaluated and addressed.
5. **Outlet structures** allow treated water to exit the BMP. If the outlet structure is clogged, flooding will occur within the BMP. Outlets should be free of sediment, trash, and debris. Erosion, scour, and damage should be evaluated.

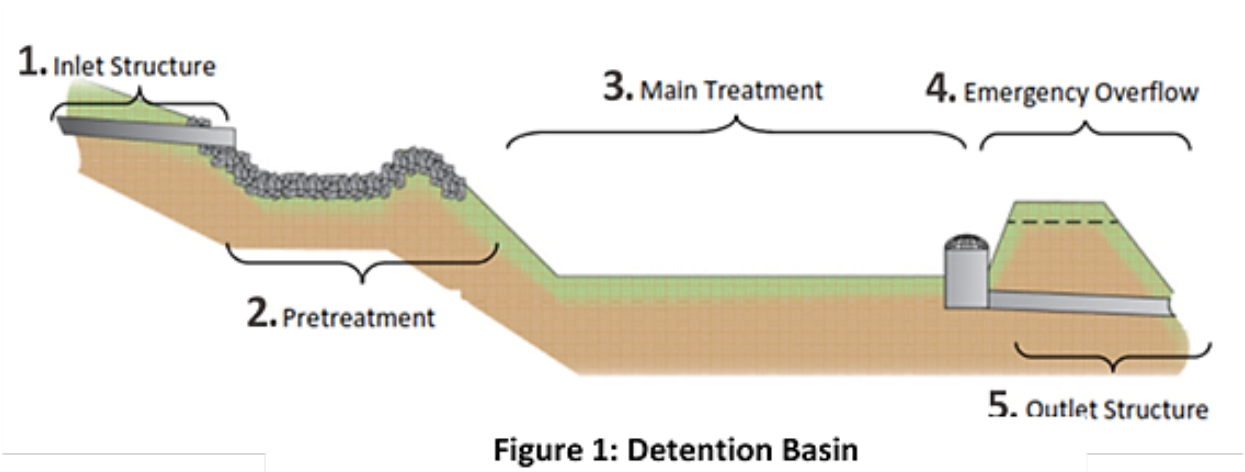


Figure 1: Common Components of an Extended Detention Basin

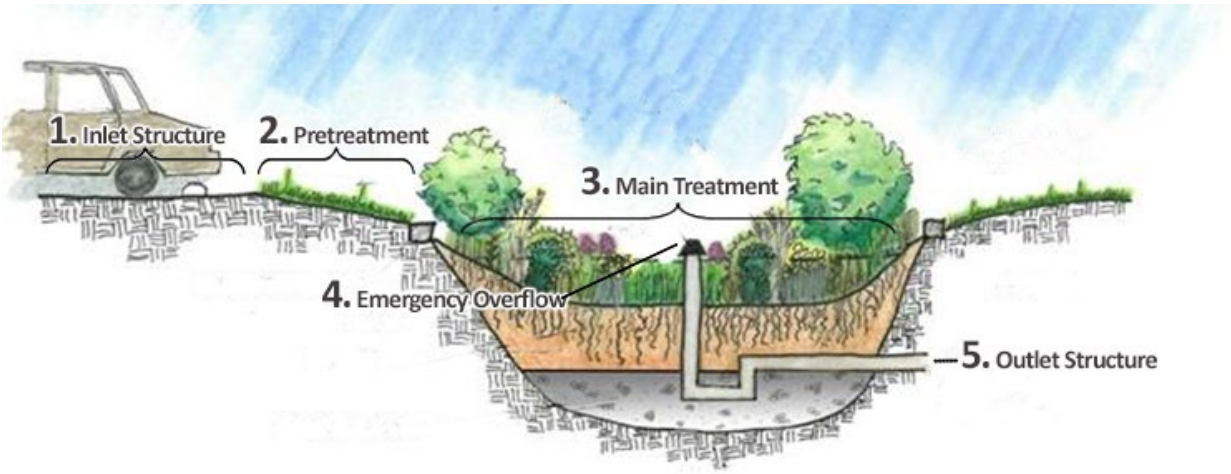


Figure 2: Common Components of a Bioretention Area

Proper inspection and maintenance of the five common components will go a long way in making sure a BMP is operating and functioning the way it was designed. Each component must be working properly. Poor maintenance or damage to just one of these components could lead to failure of the BMP. Routine inspection of these common components is very important to keep the BMP working properly and to catch and repair minor issues before they become major problems. Major problems could result in costly repairs, property damage, and/or legal problems. For example, a bioretention area that contains dead and unhealthy vegetation and sediment (Figure 3) can lead to eroded soil clogging the outlet (Figure 4). Unmaintained, these issues can lead to flooding or erosion on public or private property and the release of pollutants, such as sediment, which will require clean-up. Inspecting the vegetation in the treatment area on a seasonal basis allows adequate time to address dying or unhealthy plants, which can be treated or replaced. Inspecting the inlet structure every month allows you to clear debris that can block or divert storm water flow. A properly maintained bioretention area, as shown in Figure 5, has healthy vegetation covering the planting area as well as stone and mulch providing additional soil coverage.

Figure 3: Bioretention Area that needs maintenance to address dead and unhealthy vegetation within the main treatment area.

Figure 4: Bioretention Area that needs maintenance to address a clogged outlet structure.

Figure 5: Properly maintained bioretention area.

Each of the 10 Auburn Green Infrastructure Pilot Projects includes one or more BMPs. Inspection checklists have been developed for each BMP (Refer to Appendix C). The checklists allow the inspector to keep a record of inspections, maintenance issues, and follow-up items. They also provide guidance on the frequency of inspection needed and inspection tips. For example, some inspections need to be done only seasonally, such as the addition of replacement vegetation. Other inspections need to be done monthly, such as litter and debris removal. Table 1 below shows each the BMPS that are included in the 10 Auburn Green Infrastructure Pilot Projects, the typical inspection and maintenance activities required and the number of the applicable inspection checklist in the Appendix.

Typical maintenance items, such as mowing grass and trash removal, should be conducted as part of regular landscape or property maintenance. These activities are less expensive in terms of time and funding; however, they need to be conducted frequently. Major maintenance items, such as sediment removal and underdrain replacement, are costlier; however, they may only be necessary every few years. Table 1 give the approximate cost per year based on acreage or, more generally, by pilot project BMP area. For budgeting purposes, note that larger maintenance items could result from damage and funding may be needed on short notice.

Typical BMP maintenance activities include the activities associated with preventative maintenance that should be conducted at regular intervals, such as monthly, seasonally, or annually. In addition, BMPs may require non-routine maintenance activities as a reaction to a particular performance issue. Examples of non-routine maintenance include repairing damage from flooding or encroachment, replacing damaged components, or watering vegetation during a drought.

BMP maintenance costs in Table 1 were obtained from several sources, identified in the footnotes of Table 1. The sources consisted of general maintenance costs by BMP, costs for specific maintenance tasks, data from individual cities, and data from example projects. Professional judgment was then used to assign a specific cost to the BMP, task, or pilot project area. Because the costs of both extreme events

and day-to-day activities can be difficult to estimate, some of these costs are not included in Table 1. However, the maintenance activities are noted and should be kept in mind for both staffing and budgeting purposes.

Table 1

Type of BMP(s)	Typical Inspection and Maintenai	Cost
Stormwater Swale: *Vegetated channel that treats stormwater within small areas formed by check dams, or other means, within the swale and allows infiltration.* Use Checklist 1 in this Appendix for inspection and as a reference for additional guidance	Clear blockages from inlet structures, outlet structures, and emergency overflows.	**$175** ($350 per event (1 time over 2 years)[1])
	Soil amendment	**$100** per year[1]
	Repair of underdrain or other components.	**$0** (Not calculated)
	Cover non-vegetated areas with mulch, rock, or other appropriate cover.	**$400** ($1200 per 3 years[1])
	Maintain healthy vegetation and re-plant areas with unhealthy or dead vegetation.	**$400** per year[1]
	Remove trash and other debris.	**$0** (included during other activities)
	Identify and eliminate pollution sources.	**$400** ($200 per inspection 2 times per year[1])
	Total annual maintenance cost *(Based on calculations for bioretention areas, which have similar maintenance requirements and assumes 1 acre in size)*	**$1,475**
Permeable Pavement: *Pavers or pavement designed to allow stormwater to filter through voids in a pavement surface where it can then infiltrate into the underlying soil.* Use Checklist 2 in this Appendix for inspection and as a reference for additional guidance	Clear blockages from inlet structures, outlet structures, and emergency overflows. Ensure that stormwater is not bypassing the permeable pavement.	Included in total below.
	Vacuum sediments from surfaces.	Included in total below.
	Repair of underdrain or other components.	**$0** (Not calculated)
	Check pavement for cracking	**$0** (included during other activities)
	Remove trash and other debris.	**$0** (included during other activities)
	Identify and eliminate pollution sources.	**$0** (included during other activities)
	Total annual maintenance cost per acre of impervious surface treated	**$1,080**[3]

Bioretention/Bioswale: Shallow, vegetated depressions in the landscape that capture stormwater from the surrounding property and promote infiltration. Use Checklist 3 in this Appendix for inspection and as a reference for additional guidance	Clear blockages from inlet structures, outlet structures, and emergency overflows. Soil amendments Repair of underdrain or other components. Cover non-vegetated areas with mulch, rock, or other appropriate cover. Maintain healthy vegetation and re-plant areas with unhealthy or dead vegetation. Remove trash and other debris. Identify and eliminate pollution sources. Total per year per bioretention area *(Assumes bioretention areas are 1 acre in size)*	**$175** ($350 per event (1 time over 2 years)[1]) **$100** per year[1] **$0** (Not calculated) **$400** ($1200 per 3 years[1]) **$400** per year[1] **$0** (included during other activities) **$400** ($200 per inspection 2 times per year[1]) **$1,475**
Level Spreader: Practice that converts runoff from impervious surfaces to sheet flow over adjacent vegetated areas. This slows runoff velocities, promotes infiltration, and allows sediment and attached pollutants to settle and/or be filtered. Use Checklist 4 in this Appendix for inspection and as a reference for additional guidance	Keep level spreader level and free of sediment Conduct erosion repair and cover non-vegetated areas with mulch, rock, or other appropriate cover. Maintain healthy vegetation and re-plant areas with unhealthy or dead vegetation. Mow grass and maintain at 4-6 inches in height. Total annual maintenance cost for level spreader in the pilot project area	**$175** ($350 per event (1 time over 2 years)[1]) **$100** (1 time per year i.e. soil amendment) [1] **$0** (included during other activities) **$0** (included during other activities) **$275**
Channel Restoration: The planting of trees, shrubs and other native vegetation and/or the armoring or enhancement of waterways with rock or other materials to stabilize them and improve their ability to withstand erosion and stormwater input.	Erosion Repair Maintain healthy vegetation and re-plant areas with unhealthy or dead vegetation.	**$2,200** (1 time over 2 years at $4,400) [1] **$400** per year[1] **$2,600** per year

Use Checklist 5 in this Appendix for inspection and as a reference for additional guidance	Total annual maintenance cost for all channel restoration within the pilot project *(Based on calculations for detention ponds and bioretention areas, which have similar maintenance requirements)*	
Downspout Planter: Containers of trees or other vegetation that capture stormwater from downspouts and allow it to infiltrate into the soil or planting media. Use Checklist 6 in this Appendix for inspection and as a reference for additional guidance	Clear blockages from inlet structures, outlet structures, and emergency overflows. Soil amendments Repair of underdrain or other components. Cover non-vegetated areas with mulch, rock, or other appropriate cover. Maintain healthy vegetation and re-plant areas with unhealthy or dead vegetation. Remove trash and other debris. Identify and eliminate pollution sources. Total annual maintenance cost for all downspout planters within the pilot project *(Based on calculations for bioretention areas, which have similar maintenance requirements)*	**$175** ($350 per event (1 tim 2 years)[1]) **$100** per year[1] **$0** (Not calculated) **$400** ($1200 per 3 years[1]) **$400** per year[1] **$0** (included during other acti **$400** ($200 per inspection 2 per year[1]) **$1,475**
Subsurface Storage: Underground pipes or vaults that manage stormwater and prevent flooding through detention or extended detention. Use Checklist 7 in this Appendix for inspection and as a reference for additional guidance	Clear blockages from inlet structures, outlet structures, and emergency overflows. Vacuum accumulated sediment and debris. Remove trash and other debris. Repair scour and address erosion issues at inlets and outlets. Identify and eliminate pollution sources.	Included in total below. **$0** (included during other acti Included in total below. **$0** (included during other acti **$0** (Not calculated)

	Repair cracks, holes, depressions, animal burrows, trees, or woody vegetation on top of vault. Total annual maintenance cost per year for subsurface storage within the pilot project area	**$1,000-1,500**[2]

[1] Delaware Department of Natural Resources and Environmental Control Cost Estimate Calculations: http://www.dnrec.delaware.gov/swc/wa/Documents/AppoPCSdocs/Appendix%20E%20-%20Cost%20Calculations.pdf

[2] Maintaining Storm Water Systems: A Guidebook for Private Owners and Operators in the City of Lebanon: http://www.lebanonpa.org/DepartmentOfPublicWorks/SiteAssets/

Pages/MS4/Maintaining%20Private%20BMP%27s%20located%20within%20the%20City.pdf

[3] University of New Hampshire Stormwater Center's Forging the Link: Linking the Economic

Benefits of LID and Community Decisions: http://www.unh.edu/unhsc/forging -link-topics

Checklist 1

Stormwater Swale Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

BMP Name(s)				Today's Date:
	Stormwater Swale Name/General Location			Date of Last Inspection:
Property Info	Street Address:	City:	State:	Zip:
Who is Inspecting the Swale?	Name/Title:			Contact Name (If Different):
	Street Address (If conducted by a company, use company address):	City:	State:	Zip:
	Phone #:	Email:		
Additional Guidance	For additional guidance on BMP Maintenance and inspection, refer to the City of Auburn Green Infrastructure Pilot Project Report and the guidance listed under each inspection question on the attached checklist. All components of the BMP should be inspected and include: inlet structure, pretreatment area, main treatment area, outlet structure, and emergency overflow			

Checklist 1

Stormwater Swale Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
Pretreatment and Main Treatment						
1. Is the stormwater swale hard to access for inspection and maintenance?						
Guidance: Any obstacles blocking access and/or maintenance should be removed. If access is blocked by a permanent fixture (e.g. fence), note this on inspection form. **Schedule:** Monthly						
2. Is the stormwater swale holding water for longer than 24 hours after a storm?						
Guidance: Water should drain out of the swale in 24 hours after any rain event. If it stays in the swale longer, grass could be killed, or wetland plants could begin to grow. Check for and remove any blockages from the swale. If no blockages are found and standing water is a prevalent occurrence in the swale during otherwise dry periods, more extensive maintenance, such as regrading or repair of the underdrain, may be required. **Schedule:** Monthly						
3. Are there bare or eroding areas in the stormwater swale or pretreatment area?						
Guidance: The swale and pretreatment area should have a thick stand of grass. Bare areas and areas of erosion should be repaired and covered with sufficient vegetation or material to slow the water and prevent erosion. **Schedule**: Monthly						
4. Notice another problem? Describe in comments.						**Your Comments:**

Checklist 1

Stormwater Swale Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
Inlet Structure, Outlet Structure, and Emergency Overflow						
5. Does the inlet structure have evidence of erosion, bare spots or scour?						
Guidance: Inlet structures should have dense healthy vegetation or a rock, concrete, asphalt, or paver lining to prevent erosion. Bare soil or signs of erosion should NOT be present. Repair eroded areas and cover bare soil immediately with the appropriate vegetation or material cover. **Schedule:** Monthly						
6. Do the inlet or outlet structures or emergency overflow contain trash, sediment, debris, grass clippings or other materials that can obstruct storm water flow?						
Guidance: Remove unwanted materials and correct any other problems that block the water flow into or out of the swale or damage the grass. **Schedule:** Monthly						
7. Is there evidence of erosion or scour at the outlet structure or emergency overflow?						
Guidance: Outlet structures and emergency overflows should not have any signs of erosion and should be covered with sufficient grass or material to slow the water and prevent erosion. If signs of erosion are visible, install a rock lining that extends at least 5' beyond the area of erosion. Consult an experienced professional if you have questions on the size and type of rock. **Schedule:** Monthly						
8. Is there visual evidence of pollutants at the outlet structure (e.g. oil, odd discoloration, stains, etc.)?						
Guidance: Visually check the swale and outlet structure location. Look for discolored or stained grass or significant stands of unhealthy vegetation. Also look for stains at the outlet structure. If a persistent or frequent discoloration occurs, this could be a sign that pollutants have been introduced into the swale. **Schedule:** Monthly						

Checklist 1

Stormwater Swale Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
Pretreatment and Main Treatment						
9. Is the grass overgrown or in need of cutting?						
Guidance: Mow grass to 4-6 inches in height and remove the clippings. Do not dispose of clippings or other waste in the grass swale. **Schedule:** Monthly						
10. Is the grass healthy, and does it cover 100% of the stormwater swale?						
Guidance: The stormwater swale should have a healthy, thick cover of grass on the sides and in the bottom of the swale. Consider aerating and over-seeding in the fall to ensure vegetation health. **Schedule:** Seasonally						
8. Are there signs of underdrain blockage? Signs include frequent standing water, hard-packed soil, etc.						
Guidance: If the underdrain is clogged, it may require cleaning or replacement. If the soil is compacted, the entire planting layer may need repair to restore percolation. Contact an experience professional if needed. **Schedule:** Monthly						
9. Notice another problem? (describe in comments)						**Your Comments:**

Checklist 1

Stormwater Swale Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
Property Draining to Dry Water Quality Swale or Enhanced Swale						
10. Is there litter, grass clippings, trash, debris or other materials that could enter the stormwater swale via storm water or wind?						
Guidance: Trash and other materials can be carried into the stormwater swale, causing blockages. Remove undesirable materials and keep the property clean. **Schedule:** Monthly						
11. Are there stockpiles of soil, chemicals, equipment or other materials that could be a source of pollutants washing into the stormwater swale during a storm?						
Guidance: Stockpiled materials can contain pollutants that are harmful or that can be hazardous. Remove or cover undesirable materials, fully preventing their exposure to rainfall or storm water. **Schedule:** Monthly						
12. Are there areas of erosion or exposed soil/bare earth that could be a source of sediment washing into the stormwater swale during a storm?						
Guidance: Too much sediment washing into a stormwater swale can reduce the water storage and conveyance in the swale. Repair and revegetate all areas of erosion or exposed soil. If vegetation is not intended for these areas, cover them with mulch, wood chips, pavement or another hard surface to prevent sediment erosion. **Schedule:** Weekly						
13. Do activities occur in the area that may cause unusual or substantial amounts of pollutants to be discharged to the stormwater swale? Activities include car or equipment washing, pet walking, construction vehicle traffic, etc.						
Guidance: Implement policies to prevent these activities from occurring or take steps to prevent the pollutants from reaching the stormwater swale, such as washing cars in areas that drain to the wastewater system, street or parking lot sweeping, pet waste pickup stations, etc. **Schedule:** Monthly						
14. Notice another problem? Describe in comments.						**Your Comments:**

Checklist 1
Stormwater Swale Inspection Form

Use this page for any notes, comments, or questions generated by your inspection. If you are using this page to continue your notes from a previous section, please include the section name and section number. You may also use this page to address issues not covered on the inspection form.

Checklist 1
Stormwater Swale Inspection Form

Provide a photograph(s) of your BMP to document the annual compliance inspection.

Photograph Description:	**Photograph Description:**

Checklist 1
Stormwater Swale Inspection Form

Date Photograph Taken:	Date Photograph Taken:

Checklist 2

Permeable Pavement Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

BMP Name(s)				Today's Date:
	Permeable Pavement Name/General Location			Date of Last Inspection:
Property Info	Street Address:	City:	State:	Zip:
Who is Inspecting the Permeable Pavement?	Name/Title:		Contact Name (If Different):	
	Street Address (If conducted by a company, use company address):	City:	State:	Zip:
	Phone #:	Email:		
Additional Guidance	For additional guidance on BMP Maintenance and inspection, refer to the City of Auburn Green Infrastructure Pilot Project Report and the guidance listed under each inspection question on the attached checklist. All components of the BMP should be inspected and include: inlet structure, pretreatment area, main treatment area, outlet structure, and emergency overflow			

Checklist 2

Permeable Pavement Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
Main Treatment						
1. Is the BMP difficult to access for inspection and maintenance?						
Guidance: Any obstacles blocking access to or maintenance of the permeable pavement should be removed. Put a note in this form if access is blocked by a permanent fixture (e.g. fence) that is not easily removed. **Schedule:** Monthly						
2. Are trash, sediment, debris, grass clippings, or other materials that can obstruct storm water flow on or adjacent to the pavement surface?						
Guidance: Remove unwanted materials and correct any other problems that block the water flow. **Schedule:** Monthly						
3. Do activities occur in the area that may cause unusual or substantial amounts of pollutants (especially oil and grease) to be discharged through the pavement?						
Guidance: Activities in the drainage area should minimize oil, grease, and sediment from reaching the draining surface. **Schedule:** Weekly						
4. Is there evidence of deterioration or cracking of the pavement? Is there any damage or erosion to the inlets or outlets?						
Guidance: There should be no signs of cracking or erosion. If these are found, repair or replace any damaged material. **Schedule**: Monthly						
5. Is water storm water bypassing the permeable surface?						
Guidance: Storm water should be drained into surface generally 1-2 hours of a storm and should not be flowing off of the surface into adjacent areas. **Schedule:** Monthly						

Checklist 2

Permeable Pavement Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
6. Is there any visual evidence of long-term ponding or standing water (e.g., stains, odors, etc)?						
Guidance: Remove unwanted materials and correct any other problems that can cause clogging or otherwise prevent percolation of storm water into the permeable pavement. **Schedule:** Monthly						
7. Does the area surrounding the practice contain exposed soil or bare earth?						
Guidance: The area surrounding the permeable pavement should be maintained (e.g., grass mowed regularly, no exposed soil near the draining surface, **Schedule:** Weekly						
8. Are any clean-out caps missing?						
Guidance: Visually inspect for missing or damage components and repair or replace as needed. **Schedule:** Monthly						
9. Has the underdrain system been flushed properly, displaying no clogging?						
Guidance: The underdrain system should be flushed annually (or sooner if needed) and no clogs should be present in the draining system. **Schedule:** Annually						
10. Notice another problem? Describe in comments.						**Your Comments:**

Checklist 2
Permeable Pavement Inspection Form

Use this page for any notes, comments, or questions generated by your inspection. If you are using this page to continue your notes from a previous section, please include the section name and section number. You may also use this page to address issues not covered on the inspection form.

Checklist 2
Permeable Pavement Inspection Form

Provide a photograph(s) of your BMP to document the annual compliance inspection.

Photograph Description:	**Photograph Description:**

Checklist 2
Permeable Pavement Inspection Form

Date Photograph Taken:	Date Photograph Taken:

Checklist 3

Bioretention Area Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

BMP Name(s)				Today's Date:
	Bioretention Area Name/General Location			Date of Last Inspection:
Property Info	Street Address:	City:	State:	Zip:
Who is Inspecting the Bioretention?	Name/Title):		Contact Name (If Different):	
	Street Address (If conducted by a company, use company address):	City:	State:	Zip:
	Phone #:	Email:		
Additional Guidance	For additional guidance on BMP Maintenance and inspection, refer to the City of Auburn Green Infrastructure Pilot Project Report and the guidance listed under each inspection question on the attached checklist. All components of the BMP should be inspected and include: inlet structure, pretreatment area, main treatment area, outlet structure, and emergency overflow			

Checklist 3

Bioretention Area Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
Inlet, Pretreatment, and Outlet Structures						
1. Are trash, sediment, debris, grass clippings, or other similar materials in the inlet or pretreatment structures?						
Guidance: Remove unwanted materials and correct any other problems that clog the mulch and soil or block the water flow into or out of the BMP. **Schedule:** Weekly						
2. Have curbs, gutters, grates, or other similar components been damaged or altered in any way that disrupts the flow of storm water into or out of the BMP?						
Guidance: Repair damage or alterations before the next storm, if possible. If components have been intentionally altered to resolve a drainage or flooding issue, consult a qualified professional for further guidance. Bioretention components should not be altered. **Schedule:** Weekly						
3. Is there unhealthy vegetation, exposed soil, or evidence of soil erosion in the pretreatment structure?						
Guidance: Healthy vegetation should cover pretreatment structures with no signs of erosion or bare soil. Replace any dead or unhealthy vegetation. Repair areas of erosion and re-seed or re-sod. Native species are preferred. **Schedule**: Weekly for vegetation and exposed soil. Monthly for evidence of soil erosion.						
4. Are trees, shrubs, or other woody vegetation present in the pretreatment structure?						
Guidance: Trees/shrubs can block water flow. If needed, remove woody vegetation and stabilize exposed soil with appropriate, non-woody vegetation. Native species are preferred. **Schedule:** Monthly						
5. Notice another problem? Describe in comments.						**Your Comments:**
Main Treatment Area						

Checklist 3

Bioretention Area Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
6. Are trash, sediment, debris, leaves, grass clippings, or other similar materials present in the main treatment area?						
Guidance: Remove unwanted materials and correct any other problems that can cause clogging or otherwise prevent percolation of storm water into the soil. **Schedule:** Weekly						
7. Are there signs of human encroachment in the main treatment area unrelated to maintenance, such as compacted or displaced mulch, damaged plants, tire tracks, or other?						
Guidance: Repair or replace protection measures if damaged (e.g, fences, hedges, signs) Increase protection measures if this is a frequent problem. Rake and refresh mulch and soil layers to loosen compacted areas. **Schedule:** Monthly						
8. Is there evidence of soil erosion or are there patches of exposed soil?						
Guidance: Repair the erosion or bare soil areas with vegetation and/or mulch. Identify the cause of erosion and take steps to prevent future occurrences. **Schedule:** Monthly						
9. Are there signs of soil clogging or underdrain blockage? Signs include frequent standing water, hard-packed planting layer, etc.						
Guidance: If the underdrain is clogged, contact the City of Birmingham. If the soil is compacted, the entire planting layer may need repair to restore percolation. **Schedule:** Monthly						
10. Notice another problem? Describe in comments.						**Your Comments:**
Main Treatment Area Vegetation (Trees, Shrubs, Grasses)						

Checklist 3

Bioretention Area Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
11. Is vegetation overgrown and in need of weeding, pruning, or clipping?						
Guidance: Remove overgrown vegetation. Do not dispose of clippings and other waste in the bioretention area. **Schedule:** Seasonally						
12. Do plants or trees (not including weeds) cover less than 75% of the planting area?						
Guidance: Supplement vegetation as needed to achieve at least 75% planting area coverage. Native species are preferred. **Schedule:** Seasonally						
13. Are diseased, dying, or dead plants present? At least 85% of shrubs and grasses and 100% of trees must be healthy and growing.						
Guidance: Remove and replace unhealthy or dead vegetation. Native species are preferred. Determine and correct the cause of vegetation health problems. **Schedule:** Seasonally						
14. Notice another problem? Describe in comments.						**Your Comments:**

Checklist 3

Bioretention Area Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
Property Draining to Bioretention Area						
15. Are litter, trash, debris, sediment, grass clippings, or other materials present in the area?						
Guidance: Trash and other materials can wash into the bioretention area during a storm, potentially clogging the inflow or outflow areas, the planting area, and the underdrain. Remove undesirable materials and keep the property clean. **Schedule:** Weekly						
16. Are there stockpiles of soil, chemicals, equipment, or other materials that could be a source of pollutants washing into the bioretention area during a storm?						
Guidance: Stockpiled materials can contain pollutants that are harmful to plants or that can otherwise be hazardous. Remove or cover undesirable materials, fully preventing their exposure to rainfall or storm water runoff. **Schedule:** Weekly						
17. Are there areas of erosion or exposed soil/bare earth that could be a source of sediment washing into the bioretention area during a storm?						
Guidance: Too much sediment washing into a bioretention area can clog the planting area. Repair and revegetate all areas of erosion or exposed soil. If vegetation is not intended for those areas, cover them with mulch, wood chips, pavement, or another hard surface to prevent sediment erosion, **Schedule:** Weekly						
18. Do activities nearby that may cause unusual or substantial amounts of pollutants to be discharged to the bioretention area? Activities include car or equipment washing, pet walking, construction vehicle traffic, etc.						
Guidance: Prevent these activities from occurring or take steps to prevent the pollutants from reaching the bioretention area, such as washing cars in areas that drain to the wastewater system, conducting street or parking lot sweeping, installation of pet waste pickup stations, etc. **Schedule:** Weekly						

Checklist 3

Bioretention Area Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
19. Notice another problem? Describe in comments.						**Your Comments:**

Checklist 3
Bioretention Area Inspection Form

Use this page for any notes, comments, or questions generated by your inspection. If you are using this page to continue your notes from a previous section, please include the section name and section number. You may also use this page to address issues not covered on the inspection form.

Checklist 3
Bioretention Area Inspection Form

Provide a photograph(s) of your BMP to document the annual compliance inspection.

Photograph Description:	**Photograph Description:**

Checklist 3
Bioretention Area Inspection Form

Date Photograph Taken:	Date Photograph Taken:

Checklist 4

Level Spreader Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

BMP Name(s)				Today's Date:
	Level Spreader Name/Location			Date of Last Inspection:
Property Info	Street Address:	City:	State:	Zip:
Who is Inspecting the Sheet Flow area?	Name/Title			Contact Name (If Different):
	Street Address (If conducted by a company, use company address):	City:	State:	Zip:
	Phone #:	Email:		
Additional Guidance	For additional guidance on BMP Maintenance and inspection, refer to the City of Auburn Green Infrastructure Pilot Project Report and the guidance listed under each inspection question on the attached checklist. All components of the BMP should be inspected and include: inlet structure, pretreatment area, main treatment area, outlet structure, and emergency overflow			

Checklist 4

Level Spreader Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
Pretreatment and Main Treatment						
1. Is the level spreader hard to access for inspection and maintenance?						
Guidance: Any obstacles blocking access and/or maintenance should be removed. If access is blocked by a permanent fixture (e.g. fence), note this on inspection form. **Schedule:** Monthly						
2. Is the sheet flow area downstream of the level spreader holding water for longer than 1 days after a storm?						
Guidance: Water should drain out of the sheet flow area in 1 days after any rain event. If it stays in the sheet flow area longer, grass could be killed, or wetland plants could begin to grow. Check for and remove any blockages from the sheet flow area. If no blockages are found and standing water is a prevalent occurrence in the sheet flow area during otherwise dry periods, more extensive maintenance, such as regrading, may be required. **Schedule:** Monthly						
3. Are there bare or eroding areas near the level spreader?						
Guidance: The area should have a thick stand of grass. Bare areas and areas of erosion should be repaired and covered with sufficient vegetation or material to slow the water and prevent erosion. **Schedule**: Monthly						
4. Does the level spreader have evidence of erosion, scour, or damage?						
Guidance: Repair eroded areas and damaged components as soon as possible. A qualified professional may be needed for some repairs. **Schedule:** Annually						
5. Notice another problem? Describe in comments.						**Your Comments:**

Checklist 4

Level Spreader Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
Pretreatment and Main Treatment						
6. Is the grass overgrown or in need of cutting?						
Guidance: Mow grass to 4-6 inches in height and remove the clippings. Do not dispose of clippings or other waste near the level spreader or in the downstream sheet flow area. **Schedule:** Monthly						
7. Is the grass healthy, and does it cover 100% of the sheet flow area downstream of the level spreader?						
Guidance: The grass sheet flow area should have a healthy, thick cover of grass on the sides and in the bottom of the sheet flow area. Consider aerating and over-seeding in the fall to ensure vegetation health. Woody vegetation is not allowed in the sheet flow area and should be removed. **Schedule:** Seasonally						
8. Notice another problem? (describe in comments)						**Your Comments:**

Checklist 4

Level Spreader Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
Property Draining to Sheet Flow area						
9. Is there litter, grass clippings, trash, debris or other material that could reach the level spreader via storm water or wind?						
Guidance: Trash and other materials can be carried to the level spreader, causing blockages. Remove undesirable materials and keep the property clean. **Schedule:** Monthly						
10. Are there stockpiles of soil, chemicals, equipment or other materials that could be a source of pollutants washing toward the level spreader during a storm?						
Guidance: Stockpiled materials can contain pollutants that are harmful or that can be hazardous. Remove or cover undesirable materials, fully preventing their exposure to rainfall or storm water. **Schedule:** Monthly						
11. Are there areas of erosion or exposed soil/bare earth that could be a source of sediment washing toward the level spreader during a storm?						
Guidance: Repair and revegetate all areas of erosion or exposed soil. If vegetation is not intended for these areas, cover them with mulch, wood chips, pavement or another hard surface to prevent sediment erosion. **Schedule:** Monthly						
12. Do activities occur in the area that may cause unusual or substantial amounts of pollutants to be discharged near the level spreader? Activities include car or equipment washing, pet walking, construction vehicle traffic, etc.						
Guidance: Implement policies to prevent these activities from occurring or take steps to prevent the pollutants from reaching the level spreader and surrounding area, such as washing cars in areas that drain to the wastewater system, street or parking lot sweeping, pet waste pickup stations, etc. **Schedule:** Monthly						
13. Notice another problem? Describe in comments.						**Your Comments:**

Checklist 4

Level Spreader Inspection Form

Use this page for any notes, comments, or questions generated by your inspection. If you are using this page to continue your notes from a previous section, please include the section name and section number. You may also use this page to address issues not covered on the inspection form.

Checklist 4

Level Spreader Inspection Form

Provide a photograph(s) of your BMP to document the annual compliance inspection.

Photograph Description:	**Photograph Description:**
Date Photograph Taken:	**Date Photograph Taken:**

Checklist 4
Level Spreader Inspection Form

Checklist 5

Channel Restoration Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

BMP Name(s)				Today's Date:
	Channel Restoration Area Name/Location.			Date of Last Inspection:
Property Info	Street Address:	City:	State:	Zip:
Who is Inspecting the Storm Water Wetland?	Name/Title:			Contact Name (If Different):
	Street Address (If conducted by a company, use company address):	City:	State:	Zip:
	Phone #:	Email:		
Additional Guidance	For additional guidance on BMP Maintenance and inspection, refer to the City of Auburn Green Infrastructure Pilot Project Report and the guidance listed under each inspection question on the attached checklist. All components of the BMP should be inspected and include: inlet structure, pretreatment area, main treatment area, outlet structure, and emergency overflow.			

Checklist 5

Channel Restoration Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
Inlet Structure, Outlet Structure, and Emergency Overflow						
1. Is the channel restoration area difficult to access for inspection and maintenance?						
Guidance: Any obstacles blocking access to, or maintenance of, these components should be removed. Put a note in this form if access is blocked by a permanent fixture (e.g. fence) that is not easily removed. **Schedule:** Monthly						
2. Are trash, sediment, debris, grass clippings, or other materials that can obstruct storm water flow present?						
Guidance: Remove unwanted materials and correct any other problems that block the water flow. **Schedule:** Monthly						
4. Is there bare soil or evidence of erosion or scour?						
Guidance: If the channel is eroding or showing scour, it may need to be covered with sufficient vegetation or other material. Consult an experienced professional if you have questions on maintaining the channel banks. **Schedule:** Seasonally						
6. Is there visual evidence of pollutants (oil, odd discoloration, stains, etc.)?						

Checklist 5

Channel Restoration Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
Guidance: Visually inspect all areas of the BMP for evidence of sheens, staining or discoloration. If found, inspect areas draining to the channel and remove potential pollutant sources. Many pollutants can negatively impact the vegetation growing on the banks of the channel or the channel itself. **Schedule:** Monthly						
7. Notice another problem? Describe in comments.						**Your Comments:**
Main Treatment						
9. Does the channel bank vegetation appear yellow, diseased, or to be dying?						
Guidance: If the vegetation is not healthy, appears to be dying or diseased, it should be removed and replaced. Do not apply fertilizer or pesticides to the vegetation, as these materials could travel to waterways and cause pollution. **Schedule:** Seasonally						
10. Is the vegetation overgrown? Are invasive species present?						
Guidance: Remove the overgrowth or invasive vegetation and revegetate as necessary so that the surface coverage density is appropriate. **Schedule:** Annually						
11. Notice another problem? Describe in comments.						**Your Comments:**
Property Draining to Channel Restoration Area						

Checklist 5

Channel Restoration Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
13. Are there litter, grass clippings, trash, debris or other materials that could enter the channel?						
Guidance: Trash and other materials can be carried into the channel. Remove undesirable materials and keep the property clean. **Schedule:** Monthly						
14. Are there areas of erosion or exposed soil/bare earth that could be a source of sediment washing into the channel during a storm?						
Guidance: Repair and revegetate all areas of erosion or exposed soil. If vegetation is not intended for these areas, cover them with mulch, wood chips, pavement or another hard surface to prevent sediment erosion. **Schedule:** Seasonally						
15. Do activities occur in the area that may cause unusual or substantial amounts of pollutants to be discharged to the channel? Activities include car or equipment washing, pet walking, construction vehicle traffic, etc.						
Guidance: Prevent these activities from occurring or take steps to prevent the pollutants from reaching the channel, such as washing cars in areas that drain to the wastewater system, street or parking lot sweeping, pet waste pickup stations, etc. **Schedule:** Monthly						
16. Notice another problem? Describe in comments.						**Your Comments:**

Checklist 5
Channel Restoration Inspection Form

Use this page for any notes, comments, or questions generated by your inspection. If you are using this page to continue your notes from a previous section, please include the section name and section number. You may also use this page to address issues not covered on the inspection form.

Checklist 5
Channel Restoration Inspection Form

Provide a photograph(s) of your BMP to document the annual compliance inspection.

Photograph Description:	**Photograph Description:**

Checklist 5
Channel Restoration Inspection Form

Date Photograph Taken:	Date Photograph Taken:

Checklist 6

Downspout Planter Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

BMP Name(s)				Today's Date:
	Downspout Planter Name/Location			Date of Last Inspection:
Property Info	Street Address:	City:	State:	Zip:
Who is Inspecting the Urban Bioretention?	Name/Title:			Contact Name (If Different):
	Street Address (If conducted by a company, use company address):	City:	State:	Zip:
	Phone #:	Email:		
Additional Guidance	For additional guidance on BMP Maintenance and inspection, refer to the City of Auburn Green Infrastructure Pilot Project Report and the guidance listed under each inspection question on the attached checklist. All components of the BMP should be inspected and include: inlet structure, pretreatment area, main treatment area, outlet structure, and emergency overflow.			

Checklist 6

Downspout Planter Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
Pretreatment and Main Treatment						
1. Is the BMP difficult to access for inspection and maintenance?						
Guidance: Any obstacles blocking access to or maintenance of the downspout planter area should be removed. Put a note in this form if access is blocked by a permanent fixture (e.g. fence) that is not easily removed. **Schedule:** Monthly						
2. Is the area around the BMP damaged in any way? Look for cracks, breaks, depressions, upheaval, spalling, etc.						
Guidance: Cracks, breaks, depressions, upheaval and spalling of the planter itself or surrounding pavement area can be a sign of structural or seepage problems. Planter box damage can result in storm water bypassing or inundation of the planting area, erosion, loss of plant material, mulch or soil media, and a loss of structural integrity. Determine the cause and repair. Consider adding or changing protection measures to prevent future damage. (Note that upheaval can be caused by tree roots within the planter, which could require repair of both the structure and the planting bed.) **Schedule:** Monthly						
3. Are trash, sediment, debris, grass clippings or other materials present in the downspout planter?						
Guidance: Remove unwanted materials and correct any problems that can cause clogging or otherwise prevent infiltration of storm water into the soil. **Schedule:** Weekly						
4. Is the mulch thinning or decaying?						
Guidance: Maintain 2 to 4 inches of loosely packed high-quality mulch. Loosen compacted or decaying mulch with a rake before applying new mulch. **Schedule:** Seasonally						
5. Are there signs of human or pet encroachment in the planting area, unrelated to maintenance, such as compacted or displaced mulch, damaged plants, pet waste, or other?						
Guidance: Repair or replace protection measures if damaged (e.g., fences, shrubs/hedges, signs, etc.). Increase protection measures if this is a frequent problem. Rake and refresh mulch and top soil to loosen lightly compacted areas. **Schedule:** Monthly						
6. Is there soil erosion or are there patches of bare soil?						
Guidance: Repair the erosion or bare soil areas with vegetation or mulch. Identify the cause of erosion and take steps to prevent future occurrences. **Schedule:** Monthly						

Checklist 6

Downspout Planter Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
7. Are there signs of soil clogging or underdrain blockage? Signs can include frequent standing water than does not drain within 24 hours or hard-packed soil.						
Guidance: Check the underdrain for clogging. Loosen and refresh mulch and topsoil if needed. If the soil is compacted, it may need to be restored with replacement or amendment. **Schedule:** Monthly						
8. Is the underdrain clogged (check observation wells if present)?						
Guidance: The underdrain must not be blocked or clogged for the BMP to function properly. If the problem cannot be resolved by accessing the blockage through the underdrain pipe, then the planted area will likely need to be removed and then restored after fixing the underdrain. In this case, consult a civil engineer or landscape architect to ensure that the underdrain and planting area are restored. **Schedule:** Monthly						
9. Is vegetation overgrown and in need of weeding, pruning or clipping?						
Guidance: Remove overgrown vegetation. Do not dispose of clippings and other landscape debris in the downspout planter itself. **Schedule:** Seasonally						
10. Do plants and trees (not including weeds) cover less than 75% of the planting area (check NA for tree boxes)?						
Guidance: Supplement vegetation as needed to achieve at least 75% coverage of the planting area. Native species are preferred. **Schedule:** Seasonally						
11. Are diseased, dying, or dead plants present? (Note that at least 85% of shrubs and grasses and 100% of trees must be healthy and growing as expected.)						
Guidance: Remove and replace unhealthy or dead vegetation. Native species are preferred. Determine and correct the cause of unhealthy vegetation. **Schedule:** Seasonally						
12. Notice another problem? Describe in comments.						**Your Comments:**

Checklist 6

Downspout Planter Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
Property Draining to Bioretention Area						**Success Factors: Vegetation, Protection, Draindown, and Cleanliness**
13. Is there litter, grass clippings, trash, debris or other materials that could be washed, blown or dumped in the downspout planter?						
Guidance: Trash and other materials can be carried into the BMP, potentially clogging the inflow and outflow structures, the planting area and underdrain. Remove undesirable materials and keep the property clean. **Schedule:** Weekly						
14. Are there stockpiles of soils, chemicals, equipment, or other materials that could be a source of pollutants entering the downspout planter during a storm?						
Guidance: Stockpiled materials can contain pollutants that are harmful or that can be hazardous. Remove or cover undesirable materials, fully preventing their exposure to rainfall or storm water. **Schedule:** Weekly						
15. Are there areas of erosion or exposed soil/bare earth that could be a source of soil washing into the BMP during a rainfall?						
Guidance: Too much soil washing into a downspout planter can clog the planting area. Repair and revegetate all areas of erosion or exposed soil. If vegetation is not intended for these areas, cover them with mulch, wood chips, pavement or another measure to prevent erosion. **Schedule:** Monthly						
16. Do activities occur in the area that may cause unusual or substantial amounts of pollutants to be discharged? Activities include car or equipment washing, pet walking, construction vehicle traffic, etc.						
Guidance: Prevent these activities from occurring or take steps to prevent the pollutants from reaching the downspout planter, such as washing cars in areas that drain to the wastewater system, street or parking lot sweeping, pet waste pickup stations, etc. **Schedule:** Weekly						
17. Notice another problem? Describe in comments.						**Your Comments:**
Inlet Structure, Outlet Structure, and Emergency Overflow						

Checklist 6

Downspout Planter Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
18. Are trash, sediment, debris, grass clippings or other materials that can obstruct storm water flow present in the inlet or outlet structures?						
Guidance: Remove unwanted materials and correct any other problems that block the water flow into or out of the stormwater planter. **Schedule:** Monthly						
19. Have curbs, gutters, grates, or similar components been damaged or altered in any way that disrupts the flow of storm water into or out of the BMP?						
Guidance: Repair damage or alterations before the next rainfall if possible. If components have been intentionally altered to resolve a drainage or flooding issue, consult the City of Auburn for further guidance. BMP components cannot be altered without approval. **Schedule:** Monthly						
20. Is there visual evidence of pollutants at the inlet or outlet structures (e.g., oil, odd discoloration, stains, etc.)?						
Guidance: Visually check the inlet and outlet structure location(s) and look for discoloration or staining or significant stands of unhealthy vegetation. If you can determine the cause, do so and eliminate it. **Schedule:** Weekly						
21. Notice another problem? Describe in comments.						**Your Comments:**

Checklist 6
Downspout Planter Inspection Form

Use this page for any notes, comments, or questions generated by your inspection. If you are using this page to continue your notes from a previous section, please include the section name and section number. You may also use this page to address issues not covered on the inspection form.

Checklist 6
Downspout Planter Inspection Form

Provide a photograph(s) of your BMP to document the annual compliance inspection.

Photograph Description:	**Photograph Description:**

Checklist 6
Downspout Planter Inspection Form

Date Photograph Taken:	Date Photograph Taken:

Checklist 7

Subsurface Storage Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

BMP Name(s)				Today's Date:
	Subsurface Storage Area Name/Location			Date of Last Inspection:
Property Info	Street Address:	City:	State:	Zip:
Who is Inspecting the Underground Detention?	Name/Title:			Contact Name (If Different):
	Street Address (If conducted by a company, use company address):	City:	State:	Zip:
	Phone #:	Email:		
Additional Guidance	For additional guidance on BMP Maintenance and inspection, refer to the City of Auburn Green Infrastructure Pilot Project Report and the guidance listed under each inspection question on the attached checklist. All components of the BMP should be inspected and include: inlet structure, pretreatment area, main treatment area, outlet structure, and emergency overflow.			

Checklist 7

Subsurface Storage Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
Inlet Structure, Outlet Structure, and Emergency Overflow						
1. Are the inlets, outlets, gates, valves, and other mechanical components difficult to access for operation, inspection, and maintenance?						
Guidance: Any obstacles blocking access to, or maintenance of, these components should be removed. Put a note in this form if access is blocked by a permanent fixture (e.g. fence) that is not easily removed. **Schedule:** Monthly						
2. Are trash, sediment, debris, grass clippings, or other materials that can obstruct storm water flow present in the inlet or outlet?						
Guidance: Remove unwanted materials and correct any other problems that block the water flow into or out of the area. **Schedule:** Monthly						
3. Is water flowing from the outlet when it is not expected?						
Guidance: Under normal rainfall conditions, the subsurface storage BMP is designed to drain 1 day after a rainfall. This may take longer during especially wet periods. During dry periods, an outlet that is discharging water or standing water in BMP components may indicate a clog or blockage, or even a cracked vault or pipe that is allowing landscape water or ground water to enter the system. Determine the cause and correct it. If the cause cannot be determined, call a civil engineer or the vendor of the underground detention system for assistance. **Schedule**: Monthly						
4. Is the outlet NOT flowing after a significant rain event? Or is water backing up into other parts of the storm water system?						
Guidance: Some flow should be visible at the structure outlet after most large storm events. If no flow is observed, the outlet may be clogged. If the clog is visible and accessible, remove it. If not, you may need the help of a qualified professional. **Schedule:** Monthly						

Checklist 7

Subsurface Storage Inspection Form

All items listed must be inspected unless Not Applicable (NA). Answering "Yes" indicates a need for maintenance. Please include an approximate repair date for items that require maintenance.

This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
5. Is there bare soil or evidence of erosion or scour at the outlets?						
Guidance: Outlets and the areas below them should not have any signs of erosion, and should be covered with sufficient vegetation, pavement or other material to slow the water and prevent erosion. Typically, this is a rock lining, but can be concrete, asphalt, pavers or even dense vegetation. If signs of erosion are visible at the outlet, install a rock lining that extends at least 10' beyond the area of erosion. Contact a qualified professional if you have questions on the size and type of rock. **Schedule:** Monthly						
6. Do the inlets have unhealthy vegetation, sparse rock, broken concrete/pavement, or other damaged material?						
Guidance: Inflow areas should have dense healthy vegetation or a rock, concrete, asphalt, or paver lining to prevent erosion. Bare soil or signs of erosion should NOT be present. Repair eroded areas and cover bare soil immediately with the appropriate vegetation or material cover. **Schedule:** Monthly						
7. Is there visual evidence of pollutants at the inlets or outlets (e.g., oil, odd discoloration, stains, etc.)?						
Guidance: Visually check inlets and outlets for discolored or stained grass, pavement or rocks, or significant stands of unhealthy vegetation. If a persistent or frequent discoloration occurs, contact your local jurisdiction. This could be a sign that the underground detention BMP is not operating properly or that pollutants have been introduced into it. **Schedule:** Monthly						
8. Notice another problem? Describe in comments.						**Your Comments:**
Pretreatment and Main Treatment						
9. Are there cracks, holes, depressions, animal burrows, trees, or woody vegetation on top of the vault, on the pavement, or on the pipe system?						

Checklist 7

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Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
Guidance: The area above the storage components (vault or pipe systems) should be paved, vegetated (with grass or other non-woody vegetation), or both. Animal burrows, trees and woody vegetation should be removed as soon as they are noticed. Cracks, depressions, and holes can indicate a structural problem with the storage components. Measure and log the length, width and depth of each of these problem on the inspection form and note the location of each issue on the inspection figure. Check the vault and piping system for signs of structural damage if you can do so safely. For animal burrows, call animal control for removal. Call a civil engineer or the vendor of the underground detention BMP for assistance if these problems appear to be getting worse. **Schedule:** Semi-annually						
10. Notice another problem? Describe in comments.						**Your Comments:**
Property Draining to the Underground Detention						**Success Factors: Vegetation, Protection, Draindown, and Cleanliness**
11. Are there litter, grass clippings, trash, debris, or other materials that could enter the subsurface storage BMP?						
Guidance: Trash and other materials can be carried into the BMP and block the inlets or outlets and fill up the subsurface storage area. Remove undesirable materials and keep the property clean. **Schedule:** Monthly						
12. Are there stockpiles of soil, chemicals, equipment, or other materials that could be a source of pollutants washing into the BMP during a storm?						
Guidance: Stockpiled materials can contain pollutants that are harmful or that can be hazardous. Remove or cover undesirable materials, fully preventing their exposure to rainfall or storm water. **Schedule:** Monthly						
13. Are there areas of erosion or exposed soil/bare earth that could be a source of sediment washing into the BMP during a storm?						
Guidance: Too much sediment washing into an underground detention BMP can reduce the water storage. Repair and revegetate all areas of erosion or exposed soil. If vegetation is not intended for these areas, cover them with mulch, wood chips, pavement or another hard surface to prevent sediment erosion. **Schedule:** Seasonally						

Checklist 7

Subsurface Storage Inspection Form

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This checklist details these frequency periods, and submittal of the annual form is a certification that you have met these requirements.

Inspection Question	Answer			Schedule		Describe Problem(s) and Solution(s)
	Y	N	NA	Y	N	
14. Do activities occur in the area that may cause unusual or substantial amounts of pollutants to be discharged to the subsurface storage BMP? Activities include car or equipment washing, pet walking, construction vehicle traffic, etc.						
Guidance: Prevent these activities from occurring or take steps to prevent the pollutants from reaching the BMP, such as washing cars in areas that drain to the wastewater system, street or parking lot sweeping, pet waste pickup stations, etc. **Schedule:** Monthly						
15. Notice another problem? Describe in comments.						**Your Comments:**

Checklist 7
Subsurface Storage Inspection Form

Use this page for any notes, comments, or questions generated by your inspection. If you are using this page to continue your notes from a previous section, please include the section name and section number. You may also use this page to address issues not covered on the inspection form.

Checklist 7
Subsurface Storage Inspection Form

Provide a photograph(s) of your BMP to document the annual compliance inspection.

Photograph Description:	**Photograph Description:**

Checklist 7
Subsurface Storage Inspection Form

Date Photograph Taken:	Date Photograph Taken: