Purdue University
Campus-Wide Sustainable Stormwater Modification Design

November 2009

Enginuity

ELEMENTS Engineering, LLC

PURDUE UNIVERSITY

Meliora Environmental Design, LLC
Meliora: Latin for "always better"

andropogon
landscape architecture
ecological planning & design

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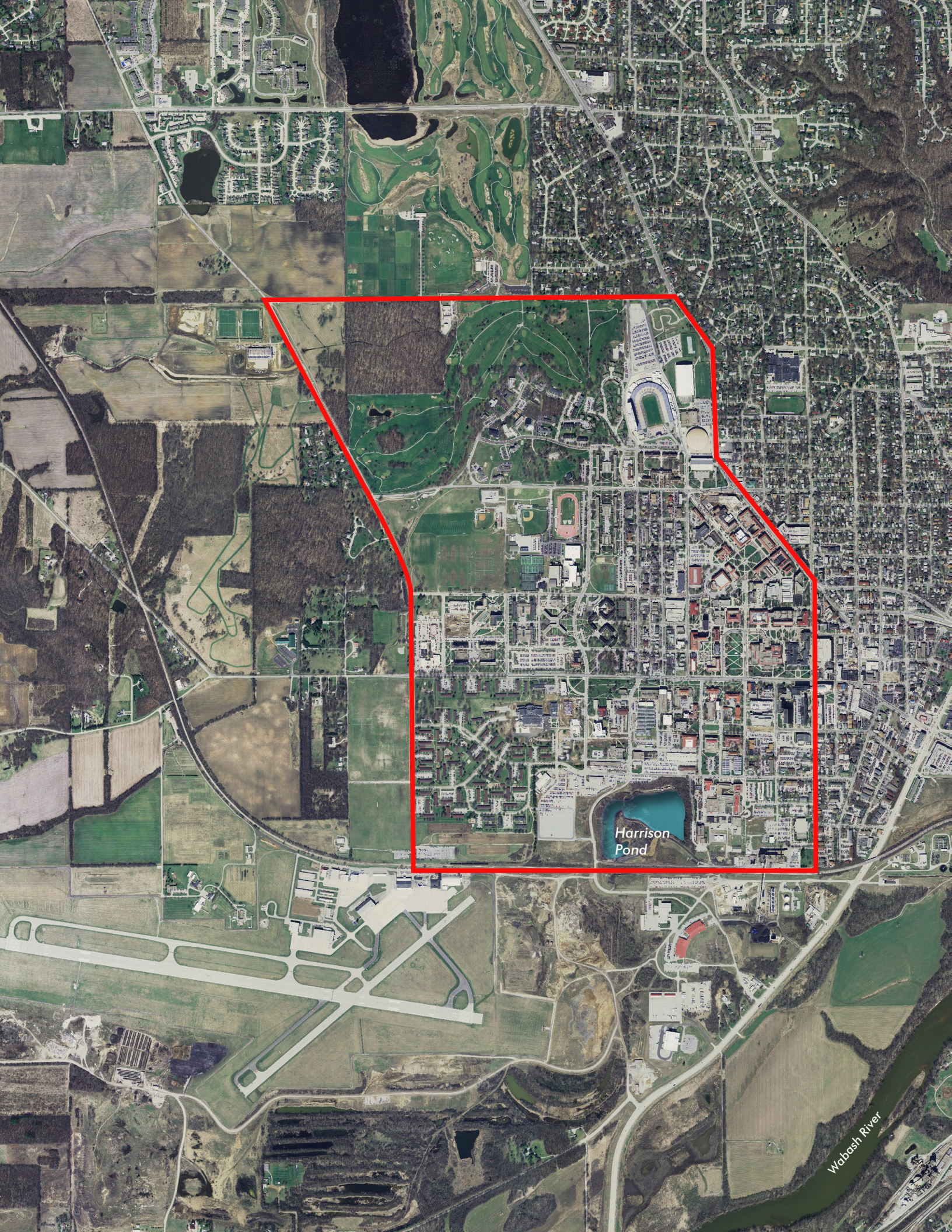
Chapter 1 - Overview

Purdue University is currently investing in a Sustainable Stormwater and Wellhead Protection Program. In keeping with the Purdue University Strategic Plan for 2008-2014 and the 2009 Campus Master Plan, this Stormwater Program represents an important change in thinking and policy from an "end-of-pipe stormwater management system" towards a long-term, sustainable approach to the Campus' water resources.

In undertaking this effort, Purdue seeks to not only protect and sustain the Campus water resources for future generations, but to lead the way as a major educational institution undertaking a "Green Infrastructure and Stormwater Retrofit" program. This program will guide future campus growth and development in a more sustainable manner with regards to water resources, and will provide an equally important template for re-thinking the existing campus landscape and stormwater systems to create a more sustainable approach to stormwater.


Harrison
Pond
Wabash River

1.1 - Background and Purpose

Purdue University and West Lafayette are dependent upon groundwater for water supply. Purdue maintains a potable water supply system and associated wellhead protection area that is inclusive of the entire campus. This water supply system draws from wells that extend into the thick sand and gravel deposits of the Teays River Valley. At the same time, approximately 584 acres of campus and adjacent city areas drain into the university's storm sewer system that ultimately discharges into Harrison Pond, a former gravel pit located in the southern portion of campus. This gravel pit appears to be hydraulically connected to the groundwater system, as there are no direct surface connections with the nearby Wabash River or any other water feature. Historically, the pond has never risen more than 5 feet in elevation, nor has it ever drained, even in extended periods of drought.

In accordance with the existing stormwater management plan, Purdue has implemented programs of good housekeeping, spill prevention and response, and sediment and erosion control to protect water quality. Additionally, a number of stormwater Best Management Practices (BMPs), such as vegetative swales and infiltration trenches, have been implemented. The University's stormwater system is permitted as an MS4 under the National Pollutant Discharge Elimination System (NPDES) Phase II Program, as a co-permittee with local government entities.

However, there is no over-arching strategy for managing stormwater comprehensively as a resource, or for protecting the quality of water that enters the pond and ultimately the groundwater. Beyond the 584 acres that drain to Harrison Pond, a significant portion of the campus discharges to the combined-sewer system of West Lafayette, contributing to the frequency and volume of combined-sewer overflows. The western portion of the campus drains to Jordan Creek, a tributary of the Wabash, and again, there is no comprehensive approach to water quality or protecting this resource.

With an increasing awareness of the issues of sustainability, and a growing recognition that groundwater, rainfall, and stormwater runoff are all interrelated components of the same water resource, Purdue has elected to develop and implement a sustainable stormwater management approach. The *2008 Purdue Strategic Plan, New Synergies*, recognizes sustainability as a specific strategy, advocating that Purdue "promote sustainability consciousness by attending to environmental and ecological stewardship". A sustainable approach to rainfall and runoff is essential for a campus that is also a wellhead protection area.

The recently adopted Campus Master Plan advocates compact growth within the existing campus core, strives to reduce traffic from the core of campus and proposes new mixed-use development along State Street. The master plan encourages new residential communities around the campus core, and redevelopment within some areas currently dedicated to surface parking lots. As this growth occurs, there is opportunity to implement stormwater measures that reduce stormwater runoff, improve water quality, and maintain groundwater recharge. A different approach to stormwater is needed for growth to occur in a sustainable manner.

At the same time, there is a need to address the existing campus, and a similar opportunity when redevelopment occurs to retrofit existing portions of campus, such as streetscapes, existing program areas, and buildings. By engaging in a sustainable approach to stormwater that addresses both future growth and the existing campus, Purdue seeks to implement a program that will sustain the water resources of the campus indefinitely.

FIG 1.1
Aerial of Purdue University Campus with Study Area Outlined

Study area

1.2 - Environmental Objectives/Guiding Principles

This Stormwater Plan has been developed to attend to the environmental and ecological stewardship of Purdue's water resources, and is intended to guide the University in an approach that will:

- Recognize that rainfall is the source of replenishment for the groundwater resource that serves both the campus and regional water supply, and increase awareness of this rainfall – water supply link.

- Pro-actively further the campus' prevention of potential pollution to the groundwater by addressing stormwater quality, Harrison Pond, and the campus as a wellhead protection area.

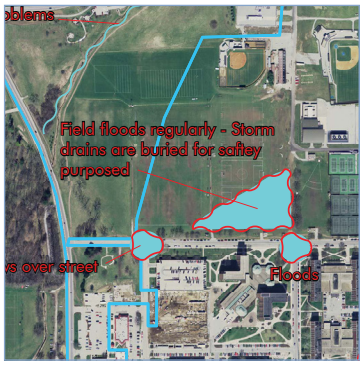
- Provide a blueprint for mitigating the adverse water quality impacts of growth and redevelopment on a campus-wide basis by defining an alternative and sustainable approach to managing stormwater runoff, including guidelines for new buildings and campus improvements while supporting the new *Purdue Strategic Plan: New Synergies*.

- Identify pilot projects and potential structural and non-structural retrofit techniques to implement this sustainable approach, and specifically to identify projects and locations that will provide the greatest impact in terms of runoff volume reduction, water quality improvement, and education.

- Promote an awareness of water in the built environment, including the important ecosystem services that healthy soils and vegetation provide as "green infrastructure" for the campus.

- Reinforce Purdue's position as a Role Model in the management of water as a resource, and educate, demonstrate and create water resource management standards that set an example for Indiana.

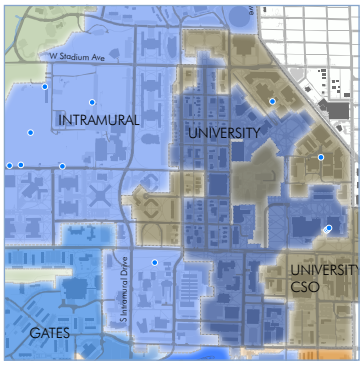
FIG 1.2
Model of Purdue University Campus with Harrison Pond in Foreground



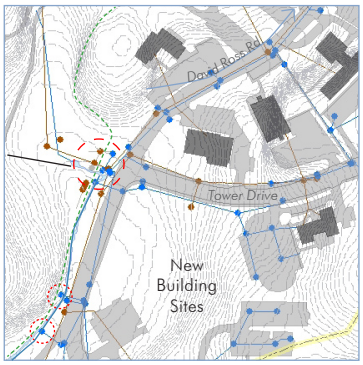
Identify Problem Areas

	Total Runoff (Acres)	Perce Impervi
Jordan Creek	267	13.6%
Intramural	290	56.8%
University	117	73.6%
University CSO	124	72.1%
Off Site	27	53.1%
and Power Plant	28	62.9%
Pond	36	7.0%

Precipitation Patterns

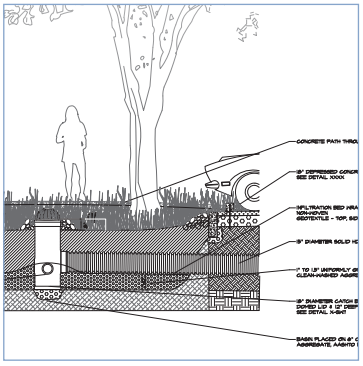


Runoff & NPSP



Case Studies

Opportunities & Constraints



Recommendations

1.3 – Process

The Development of this Stormwater Plan has had several components, including the following:

- A review of existing campus stormwater conditions, including site-specific locations of problems and opportunities, and documentation of areas of concern (localized flooding, water quality issues, etc.).

- An evaluation of the historical rainfall data at Purdue for the purpose of identifying the precipitation patterns that contribute to stormwater runoff, groundwater recharge, and pollutant discharge to Harrison Pond and other areas.

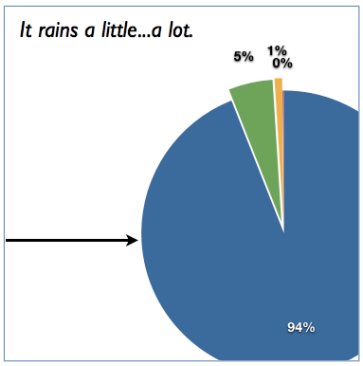
- A detailed analysis of the amount of runoff and associated pollutant loads, on an annual basis, from the different drainage areas and land uses within the campus under existing conditions. Each major drainage area (as previously defined in campus stormwater infrastructure analysis) was evaluated to determine the land use types that generated the greatest amounts of stormwater runoff and pollutants on an annual basis.

- An analysis and documentation of specific opportunities for stormwater improvements, including case studies for application of stormwater Best Management Practices (BMPs). This analysis focused on both new projects that represent an opportunity for intervention, as well as existing campus areas that warrant improvement and intervention directly.

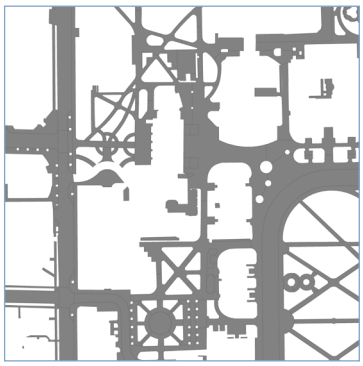
- An overall evaluation of constraints in the Campus landscape, with consideration of existing trees, utilities, and other potential conflicts, was developed to identify opportunities to integrate stormwater measures and retrofit the existing campus. This analysis was intended to identify areas available to integrate landscape-based stormwater measures.

- Development of overall prioritized recommendations for specific projects and for measures and practices for stormwater management, including concept level cost estimates.

FIG 1.3
Samples of Data and Graphics Reviewed in Later Chapters

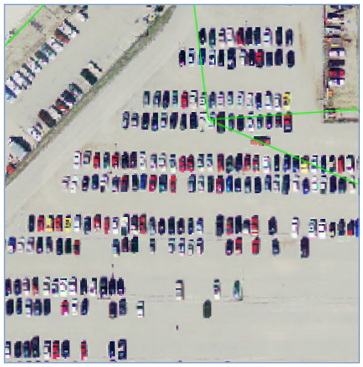


Small Storms Add Up



Streets and Sidewalks

Campus Core



Parking Lots

Remaining Natural Resources

Point Source Pollutants - Wade

1.4 – Principle Findings

Analysis of the existing campus, rainfall patterns, and future planned growth revealed several important findings:

- Addressing small, frequent rainfall events, especially from impervious surfaces, is essential for water quality. Over 93% of the storm events at Purdue result in 1-inch or less of precipitation. These small events are responsible for most of the runoff volume and pollutant generation. Implementing measures that capture the runoff from rainfall events of 1-inch or less would reduce the volume of pollutants and runoff discharged from the campus by more than 70% over the existing conditions.

- Streets and sidewalks together comprise the single largest component of the impervious area, and also generate the greatest amount of pollutants.

- Parking lots contribute significantly to runoff volume and pollutant loads to Harrison Pond and Jordan Creek. A number of campus parking areas are indicated for redevelopment within the core campus area and represent opportunities to manage stormwater for volume and quality.

- The core campus is highly impervious (as much as 74% impervious). However, even in the most densely developed areas, an evaluation of the Campus landscape with consideration of existing trees, utilities, and other potential conflicts, identified opportunities to integrate stormwater measures and retrofit the existing campus. These measures can significantly reduce the discharge of pollutants to Harrison Pond.

- There are no surface streams remaining within the core campus, however, where areas exist such as in the Jordan Creek drainage area, these remaining tributaries should be considered a resource and protected.

- Campus areas of industrial activity, such as Wade Power Plant, were not analyzed separately, but can be sources of specific pollutants, and should be evaluated for pollutant potential and appropriate stormwater measures to improve water quality.

FIG 1.4
Graphic Examples of Principle Findings

1.5 – Key Recommendations

This report includes a number of recommendations to improve water quality, reduce flooding, and implement a more sustainable approach to stormwater at Purdue University. In developing the detailed recommendations presented in this report, several key recommendations were followed:

- **Design for small frequent rainfall events.** To improve water quality, protect Harrison Pond and other receiving waters and to promote groundwater recharge, manage the small, frequent rainfall events typical to West Lafayette. Stormwater measures should be designed to capture these small events (1-inch and less) and to safely convey and hold the larger storm events. Capturing the initial volume of runoff will also reduce the impacts of larger events. Captured water can be infiltrated, reused, or returned to the atmosphere with measures such as green roofs and rain gardens.

- **A sustainable approach to water resources requires a systems approach.** Stormwater integrated with landscape measures, campus improvements, and new projects will provide benefits beyond stormwater management in a more cost effective manner. Success will require an integrated design process that considers stormwater as a component of the design from the earliest phases of a project.

- **Create a resilient stormwater system by decentralizing infrastructure.** A number of stormwater options – large and small – distributed throughout a drainage area are inherently better than a single large solution, which if it fails, will have far larger consequences.

- **Manage stormwater where it falls.** It is important to capture water upstream near the source. This will reduce the burden on conveyance systems and reduce the potential for localized downstream flooding.

- **Review all future projects for stormwater opportunities.** To truly address water quality and protection of the resource in a sustainable manner, it is imperative that Purdue implement this new approach to stormwater for all new projects, and also to move forward in a program that begins to retrofit the existing campus. This will require a long-term commitment and will likely occur over a period of many years. However, by doing so, Purdue will lead by example in addressing stormwater and water quality sustainably.

The recommendations are divided into four general categories:

1. Strategies by Drainage Area

Examination of land use types, their associated runoff volume and pollutant loading within individual drainage areas helps to guide recommendation of BMP types best suited for specific conditions.

2. Opportunities and Constraints Analysis

This analysis identifies areas within campus that are not constrained by other features and represent opportunities for stormwater interventions. This is especially important in the more densely developed and impervious portions of campus, such as the University drainage area. This analysis can serve as a "quick check" to see where there are nearby areas that may be suitable for stormwater interventions, or least less constrained than other areas.

3. Recommended Stormwater Policies and Requirements for New Projects, Campus Improvements, and Redevelopment

This is the critical component of this Plan, and lays out recommendations for all new development and redevelopment to:

- Capture all the runoff from all precipitation events of 1-inch or less.
- Encourage infiltration, reuse, and landscaped based measures.
- Educate/raise awareness for those who design and construct these projects, as well as those who live/work within them, of water in the built environment and the ecosystem services that "green infrastructure" provides.

4. Specific Case Studies and Potential Pilot Projects

The Case Studies section represents areas identified by Purdue as currently experiencing stormwater problems, or as areas of upcoming improvements where there are opportunities for stormwater interventions. A number of different types of case studies are presented to represent different recommendations, drainage areas, and Best Management Practices.

Bumpout in front of Armstrong Building on Stadium Avenue.