# Integrating Green Infrastructure in Campus Planning

## Integrating green infrastructure in campus planning [cover]

Greetings. This presentation will discuss the benefits of green infrastructure, provide an overview of the Campus RainWorks Challenge and Technical Assistance projects, and introduce considerations, tools, and processes for integrating green infrastructure in campus planning.

## Introduction to green infrastructure [chapter]

## What is green infrastructure?

“Green infrastructure” refers to a variety of practices that restore or mimic natural hydrological processes in the absence of development. While “gray” stormwater infrastructure—systems of gutters, pipes, and tunnels—is largely designed to convey stormwater away from the built environment, green infrastructure uses soils, vegetation, and other media to manage rainwater where it falls through capture, infiltration, and evapotranspiration.

Stormwater runoff and flash flooding present major challenges for urban areas and campuses: they carry contaminants, trash, and other pollutants into rivers and coastal waters, contribute to erosion and habitat loss along riparian corridors. They can cause damage to property and infrastructure and put people at risk in extreme weather events. Across the U.S., communities have used gray infrastructure to move stormwater away from homes and businesses and toward water treatment plants or directly into local water bodies.

Today, these gray infrastructure systems are not only aging but also failing to keep pace with the increasing volumes of stormwater that come with a changing climate and an increase in impervious surfaces. Changing patterns of precipitation, “cloudburst” or sudden heavy rainfall events, and more frequent extreme heat are the new normal. Green infrastructure can play an important role in addressing these emerging challenges and risks.

1. **What are the benefits of green infrastructure?**

Green infrastructure reduces and treats stormwater at its source while delivering other environmental, social, and economic benefits on campuses today and in a changing climate, including:

1. Reducing runoff, flooding, and damage to buildings in addition to improving human safety
2. Improving water and air quality
3. Supporting the efficient use of water resources
4. Providing shade and mitigating heat island as well as extreme heat
5. Reducing building energy demands
6. Creating and connecting habitats for pollinators and other wildlife
7. Providing aesthetic, placemaking, and recreational value

## EPA Campus RainWorks Challenge [chapter]

## EPA Campus RainWorks Challenge

EPA initiated the Campus RainWorks Challenge over a decade ago with the goal to advance green infrastructure practice through college and university leadership.

The Campus RainWorks Challenge is a green infrastructure design competition for American colleges and universities that seeks to engage with the next generation of environmental professionals, foster a dialogue about the need for innovative stormwater management techniques, and showcase the environmental, economic, and social benefits of green infrastructure practices.

Student teams are supported by faculty advisors and endorsed by campus facilities staff.

## EPA Campus RainWorks Technical Assistance

Organized in 2022, the Technical Assistance project was a collaboration with Morgan State University and the University of Texas at Arlington. It built on the Challenge with a one-day charrette at each University that brought together campus stakeholders to discuss green infrastructure and stormwater planning on campus. It advanced several objectives:

* 1. Explore current needs and opportunities to advance green infrastructure implementation,
	2. Foster communication between key stakeholders who are involved in research or work related to stormwater management, and
	3. Highlight the environmental, economic, and social benefits related to green infrastructure for the campus, community, and watershed.

## EPA Campus RainWorks charrette overview

Each of the day-long charrettes included presentations, campus tours, and small group breakout sessions to workshop a range of topics and themes. For both universities, charrettes were structured so that campus community members and visitors could collaboratively explore challenges and opportunities and brainstorm next steps for green infrastructure implementation.

## EPA Campus RainWorks charrette campus tours

It is critical to develop a shared understanding of the campus landscape, including its character, scale, and uses, as well as reflect on the relationship between buildings and context, open spaces, and natural systems. Touring the campus as a group is an opportunity to hear from facilities leadership, faculty, and students. It brings focus and framing to the conversations and can become a launchpad for brainstorming and collaboration.

## EPA Campus RainWorks charrette breakout sessions

Small group discussions were core features of both charrettes. The discussions were organized in two parts. First, the groups explored challenges and opportunities for green infrastructure, and later, they identified strategies and implementation approaches on campus.

At Morgan State, the breakouts were divided geographically by watershed position considering the entire campus and surrounding neighborhoods, while UT Arlington used a thematic structure for breakouts and concentrated on a focus area within the campus, around Trading House Creek.

## Campus RainWorks charrette outcomes

Each charrette pointed to a set of opportunities and proposals for green infrastructure on campus, including specific physical proposals and interventions, as well as campus research and academic opportunities, climate adaptation strategies, and capacity building initiatives.

The findings from the charrettes formed the basis of a green infrastructure report for each campus. The reports further develop and present the ideas that emerged from the charrettes and offer next steps for integrating and implementing green infrastructure on campus.

## Campus RainWorks charrette lessons learned

The charrettes underscored the ways in which green infrastructure planning has broad applicability and potential for integration with other campus initiatives. Creating the space away from the daily activities of the university proved an invaluable way to bring together campus stakeholders who may not interact regularly, as well as a platform to consider campus-wide priorities and set the stage for future collaboration.

Green infrastructure links to many other initiatives and processes on campuses. Examples include:

* 1. Green infrastructure in curriculum and research (for example in engineering, design, planning, and other disciplines)
	2. Campus plans, such as campus master plans, sustainability and resiliency plans, and transportation and open space plans
	3. Capital projects and project cycles
	4. Open space projects, increasing tree canopy and permeability
	5. Green infrastructure to support campus and municipal or regional partnerships
	6. Operations and maintenance – requiring in many cases a paradigm shift from lawns and straightforward mowing protocols to stewardship and adaptive management of native plant landscapes, including the change in aesthetics that they bring.

## Campus RainWorks charrette lessons learned

The charrettes also highlighted the importance of collaboration and the value of processes that bring together a range of stakeholders, including campus staff, faculty, students, and community members.

At Morgan State, the charrette showcased student research and design work and created space to discuss priorities and strategies for integrating green infrastructure on campus through academic leadership, capacity building, policy and governance, and physical interventions. The collaborative discussions throughout the day resulted in a commitment from Facilities staff to include students in planning for future capital projects, and a renewed interest in student-led maintenance and monitoring for campus green infrastructure.

At UT Arlington, the charrette focus on Trading House Creek was a novel opportunity to bring together numerous campus stakeholders who had individually been working to restore this watercourse and integrate it as a natural and recreational resource into larger city and regional networks. It also brought focus and energy to the importance of green infrastructure at a moment when UTA was preparing to launch a new master planning process.

The following slides further elaborate the benefits of green infrastructure and strategies for integrating it into campus planning, design, and management.

## Considerations and benefits for green infrastructure on campus [chapter]

## Planning considerations for campus green infrastructure

College and university campuses are unique as environments and communities where people live, work, study, and gather.

The campus differs in key ways from other settings that relate to its physical dimensions, its management and community, and its thought leadership as well as what is often an anchoring presence in its area.

* 1. Campus scale and underlying natural systems: many campuses encompass significant acreage, meaning that changes in the way they manage stormwater and maintain or restore natural resources such as waterbodies, watercourses, and wetlands can make a positive contribution to stormwater management in surrounding areas
	2. Centralized management and organization: unlike neighborhoods or municipalities where open spaces and natural resources may be managed by a range of organizations or agencies, campuses typically have centralized management of their physical assets in Facilities departments.
	3. Range of users and needs: campuses must serve their ever-changing bodies of students, their faculty and staff, and local residents and visitors. Taking into account the distinct needs of each constituency on campus, for example, modes and points of access and circulation routes, can inform thinking about where to install green infrastructure and its purpose.
	4. Potential for impact: campuses can have an impact by their thought leadership in a city or region, demonstrating best practices or piloting and evaluating new ideas. They are often anchor institutions that not only have a large footprint but can play a role in shifting policies and practices in their area.
	5. Relationship of campus to watershed: understanding a campus’s position in the watershed and drainage context and working with existing topography and natural drainage patterns can deliver significant benefits both within the campus and lower in the watershed, where applicable.

## Campus green infrastructure benefits and impact

Stormwater doesn’t abide by jurisdictional or campus boundaries. Depending on the location and design of the campus, it may experience stormwater flooding or contribute to stormwater pollution or flooding in surrounding areas. With strategic green infrastructure implementation, a campus can become an attractive and resilient landscape that can play an important role in mitigating flooding or water quality problems downstream.

## Campus green infrastructure benefits and impact

In addition to the more general benefits of green infrastructure, it can deliver specific benefits for campus settings that connect to protecting physical infrastructure, enhancing natural ecologies, improving the experience of students, faculty, and staff, and supporting the institution’s research and pedagogical aims. Green infrastructure can:

* 1. Improve the performance of open space assets to mitigate urban heat island and flash flood events, infiltrate stormwater, and filter pollutants to enhance water quality
	2. Limit stormwater-driven flooding that can cause damage to campus infrastructure and buildings, as well as protect the campus community from dangerous flood conditions
	3. Help a campus to meet regulatory requirements for the discharge of stormwater through increased permeability and stormwater treatment
	4. Enrich user experience on campus by providing shade, contributing to open space aesthetics and campus visual identity and placemaking
	5. Advance research and interdisciplinary collaboration between faculty, students, and staff through pilots and projects; create opportunities to experiment and learn from green infrastructure design, performance, and management
	6. Improve regional open space connectivity and resilience by leveraging campus acreage and open spaces to link natural areas, habitats, and restore waterways,
	7. Lead by example: demonstrate the principles of sustainable development to campus neighbors, and
	8. Spur regional change by advocating for new policies and practices at the municipal, regional, or state level.

## Tools and processes for integrating green infrastructure [chapter]

## Green infrastructure tools and processes

 There are numerous methods and approaches to integrating green infrastructure on campus, and this presentation will briefly discuss some avenues that campus communities can pursue, including:

* 1. Asset management and mapping
	2. Strategic green infrastructure frameworks
	3. Green infrastructure prioritization frameworks
	4. Modeling tools to support planning and design decisions, and
	5. Engagement and capacity building

## Asset management and mapping

A systematic approach to campus green infrastructure planning begins with knowing where green infrastructure facilities are, how they relate to campus natural systems, and documenting their performance. Building on this knowledge it begins to be possible to connect individual assets to an overall strategy.

Asset mapping in relation to natural systems could include:

1. Elevation and slope to understand where green infrastructure is most feasible,
2. Surface drainage flow paths to predict where flooding may occur or where to place green infrastructure,
3. Location of campus in general watershed to understand the role of campus drainage in downstream flooding and water quality impacts, and
4. Analysis of stormwater reaching campus from off-site to understand stormwater management requirements on campus, impacts to buildings and landscape, and flood impacts in rivers, if applicable.

As a first step, a campus could develop a GIS-based or other map to locate water bodies and watercourses, open space features, green infrastructure, storm sewers, inlets, and other stormwater management features on campus. This supports ongoing operations and maintenance activities and can lead to tracking, monitoring, and adaptive management to ensure the infrastructure remains in good condition over time. Having maps of these important features and amenities can also be leveraged in communication efforts with the wider campus community.

## Strategic green infrastructure framework

Developing a strategic campus green infrastructure framework can provide a conceptual and spatial basis for campus planning and establish the direction for further development and integration of green infrastructure. Several complementary components of a strategic framework that a college or university could consider include:

* 1. Guiding principles: each campus has unique needs and will need to establish guiding principles that can inform its decision-making
	2. A vision and planning framework: articulates a structure for planning, bringing in an awareness of underlying natural systems. The vision framework can layer onto guiding principles and an understanding of constraints
	3. Cloudburst vision: describes how the campus landscape functions during an extreme rain event, for example, identifying where stormwater will be held or conveyed.
	4. Multi-benefit orientation: links green infrastructure to other campus needs and goals, for example, managing extreme heat, adapting to a changing climate, improving water resource management, enhancing campus social objectives, or linking to aesthetics, placemaking, and mobility.

## Green infrastructure prioritization framework

A green infrastructure prioritization matrix complements and coordinates with the use of strategic frameworks; it can support future campus planning activities and offer a reference to summarize the design criteria of various green infrastructure measures as they relate to ecological, economic, and community considerations.

The intent of this (national) matrix is to provide campus stakeholders a starting point to consider and evaluate common green infrastructure approaches based on their suitability to site conditions, in order to advance implementation of green infrastructure on campus. The matrix describes a way to compare green infrastructure strategies as a starting point for analysis.

Also included are select **technical criteria** that outline the physical requirements for the range of green infrastructure measures, including maximum drainage area, pressure head needed, and maximum slope.

The prioritization framework, considerations, criteria, and descriptions of the design options are available as a separate resource for download.

The next few slides walk through the *qualitative* categories of considerations.

## Ecological considerations

Ecological Considerations encompass design criteria for the natural environment. They include position in the watershed based on the framework of general applicability or specific applicability to the upper, middle, or lower watershed. This category also gives an indication of the ecological co-benefits that green infrastructure can deliver, including contributing to the restoration of the natural environment, increasing tree canopy, shading hardscape or roofs, reducing air pollutants, or increasing plant diversity and habitat creation.

## Economic considerations

Economic Considerations evaluate the relative cost for both one-time installation and recurring maintenance costs. Unit costs are relative due to uncertainty around site-specific conditions and the changing fiscal context, driven by inflation and supply-chain operations. Still, green infrastructure interventions are generally found to be cheaper to maintain than traditional “gray infrastructure” solutions (i.e., subsystem pipe networks) due to the self-sufficiency of the vegetation within green infrastructure.

## Community considerations

Community considerations evaluate the social implications of green infrastructure, including the impacts that interventions have on the campus’s integration with surrounding neighborhoods, the campus’s environmental stewardship, contiguous campus character, and compliance with regulations. Metrics that are evaluated in this category and associated considerations, include:

City-Campus Integration: The degree to which the green infrastructure provides benefit to surrounding neighborhoods or provides connections between the campus and neighborhoods,

Environmental Stewardship: The degree to which an intervention contributes to the campus’s overall sustainable use and protection of the natural environment.

Aesthetic Value and Placemaking Opportunity: The degree to which green infrastructure offers additional benefits to the campus, for example, improving aesthetics, facilitating continuous campus character, and contributing better navigation and orientation for campus users and visitors.

Permitting/Coordinating: The degree to which permitting or inter-organizational coordination is necessary, because of the scale or complexity of the project.

Benefit to MS4 Compliance: The degree to which the green infrastructure advances the campus towards compliance with stormwater permit requirements, for example by reducing the amount of impervious area that exists or by increasing the amount of impervious area runoff that is captured and treated by green infrastructure.

## Modeling tools to support planning and design decisions

EPA has developed innovative models, tools, and technologies for communities to manage water runoff in urban and other environments. The resources in this toolkit incorporate green or a combination of green and gray infrastructure practices to help communities manage their water resources in a more sustainable way, increasing resilience to future climate change impacts.

For further information on EPA tools, visit the EPA website.

[www.epa.gov/green-infrastructure/green-infrastructure-modeling-tools](http://www.epa.gov/green-infrastructure/green-infrastructure-modeling-tools)

## Engagement and capacity building

As also noted from the charrette process, successful implementation and stewardship of green infrastructure requires collaboration among the many stakeholders on campus. It also requires broader education and capacity building to make stormwater planning and green infrastructure an active part of the larger campus consciousness. This capacity building could take many forms, for example, including students in planning for green infrastructure and its maintenance as part of capital projects, training maintenance staff and contractors to care for native plants, or introducing signage and sharing information to build awareness and understanding of green infrastructure among campus users and visitors.

## Campus green infrastructure design toolkit [chapter]

## Design toolkit

These green infrastructure design options represent a range of practices that could be applicable on college and university campuses. They are campus-focused (integrating with buildings, playing fields, paths, lawns, etc.). They are also available as a resource on the EPA website, where an appendix to this presentation includes full descriptions of all these measures.

The toolkit utilizes a watershed planning framework.

As drainage pathways follow gravity and stormwater seeks the lowest point to drain to, what begins as many small streams at the top of a watershed will continually combine and converge, picking up more water along the way until all water reaches one common monitoring point. This phenomenon explains why watersheds are characteristically large at the top and smaller at the bottom and results in areas in lower portions of watersheds receiving larger volumes of water.

A watershed is typically organized into three portions, each with a distinct function and priorities. Location in the watershed generally dictates the sizing of green infrastructure interventions. Since green infrastructure seeks to restore or mimic natural processes, design options should be sited across campus (sub-)watersheds based on what is naturally occurring in the water cycle.

The next few slides discuss these portions further.

## Upper watershed: infiltrate

Strategies for the upper watershed focus on infiltration of stormwater into the ground via green infrastructure to mitigate runoff and limit stormwater runoff in the lower portions of the watershed. Green infrastructure to convey water to the lower portions of the watershed is an additional priority to mimic surface runoff.

## Middle watershed: slow and store

Middle watershed green infrastructure focuses on slowing stormwater as it conveys toward inlets for existing gray stormwater infrastructure. These strategies include vegetated waterways, stormwater inlet optimization, and pockets of temporary storage (e.g., cisterns, bioretention areas with outlets). By slowing the rate at which stormwater reaches this gray infrastructure, stormwater can be more safely conveyed from the upper toward the lower watershed while mitigating the rate and frequency that infrastructure is over-capacity, to reduce the risk of localized flooding.

## Lower watershed: restore

Lower portions of watershed leverage restoration strategies to recreate the natural drainage and ecological patterns of the area. The goal is to re-establish the storage capacity and flood-tolerant vegetation that once mitigated further flooding downstream. This is especially important at the confluence of waterways where there may be additional backups of water due to hydraulic interactions.

## Conclusions [chapter]

## Conclusions

1. Green infrastructure can play an important role on college and university campuses, delivering benefits to the community and neighbors, the environment, and campus resources.
2. Campuses are unique environments given their scale, users, and management, as well as potential for impact on the physical environment of their surrounding areas and contributions to thought leadership on stormwater management.
3. Implementing green infrastructure requires a collaborative, multi-stakeholder approach. Design charrettes are one way to effectively engage campus stakeholders and build consensus around an understanding of existing conditions, campus challenges, opportunities, design strategies, and implementation pathways.
4. There are a range of tools and processes that can help support green infrastructure implementation: asset management, strategic frameworks, a prioritization matrix and tools, and modeling tools, and this body of practice and knowledge continues to grow.

This presentation and resources aim to provide a starting point for discussions, collaboration, and ultimately planning to expand green infrastructure for campus and community benefit.

Thank you!

1. For more information visit the EPA website.

[www.epa.gov/green-infrastructure](http://www.epa.gov/green-infrastructure)

1. Image credits [refer to slide]
2. Prioritization framework citations [refer to slide]