# ecological landscape stewardship plan

Penn
Facilities & Real Estate Services

University of Pennsylvania

# Acknowledgments

**This report was prepared by:**

Jonathan Alderson Landscape Architects Inc.

Biohabitats Inc.

Claudia West, LLC

John B. Ward and Co.

**University of Pennsylvania Stakeholders and Contributors:**

Yvette Bordeaux, Director, Professional Programs in Earth and Environmental Science

Chloe Cerwinka, Landscape Planner

Mark Conway, Campus Maintenance Supervisor

Rafael de Luna, Project Manager

Joseph Gaither, Housekeeping Operations Manager

Dan Garofalo, Environmental Sustainability Director

David Hollenberg, University Architect

Trish Kemper, Urban Forestry Technical Assistant, Morris Arboretum

Mark Kocent, Principal Planner

Jason Lubar, Associate Director of Urban Forestry, Morris Arboretum

Ross Leiman, Associate Director of Athletic and Recreation Facilities

Robert Lundgren, University Landscape Architect

Ken Neborak, Urban Park Supervisor

Nick Pevzner, Lecturer, Department of Landscape Architecture, Penn Design

John Reiter, Brightview Landscaping

Craig Roncace, Urban Park Manager

Sam Royer, Penn Park Supervisor

David Vann, Shoemaker Green Research Coordinator

Robert Wells, Director of Outreach, Morris Arboretum

Urban Park Staff

# Table of Contents

# Executive Summary

In the last decade, the University of Pennsylvania (Penn) has asserted itself as a leader in sustainability. Efforts like the Climate Action Plan 2.0, the incorporation of LEED into building construction, and the Sustainable SITES Initiative pilot at Shoemaker Green have driven an environmentally-minded approach toward campus management and construction. Yet opportunities exist to push these efforts further and create a campus landscape that is fully integrated within the regional ecology. The Ecological Landscape Stewardship Plan (***ELSP***) expands on these efforts by providing guidelines toward a more responsible landscape management program.

Penn continues to move toward a healthier campus landscape — a more complex micro-environment that enhances biodiversity, conserves resources, and supports the function of native ecosystems. This evolution requires a shift in management practices; any adjustments should further enhance the health of Penn's campus ecosystem and adapt to the effects of climate change while maintaining an appropriate aesthetic standard.

These practices require an ever higher degree of sophistication from maintenance teams, as well as the designers and planners who influence their work. Penn, with its commitment to the environment, can continue to advance these techniques within the campus landscape and, as a result, can further its position as an innovator in sustainability.

## DEVELOPMENT OF THE *ELSP*

The *ELSP* evaluates Penn's current landscape maintenance practices in order to inform recommendations that support a more holistic, ecological management approach. Jonathan Alderson Landscape Architects and their sub-consultants developed the *ELSP* with input and guidance from participants within Facilities and Real Estate Services (FRES), Penn professors, the Morris Arboretum, and third-party contractors involved in maintaining the campus.

Four pilot sites were chosen for the study, each representing a common campus landscape type. These sites were visited once per season over the course of a year by the consulting team, who observed maintenance practices, plant health, site systems, and user activity. In addition to site analysis, interviews and group discussions allowed the consulting team to assess obstacles associated with administrative and staffing efforts.

## RECOMMENDATIONS

The *ELSP* organizes recommendations into four key areas:

- Planning, design, and construction
- Maintenance practices
- Administrative Structure
- Outreach

Promoting landscape ecology begins with planning, design, and construction. Penn's more recent projects, in particular Penn Park and Shoemaker Green, are excellent examples already advancing the concept of an ecological landscape and demonstrating that a robust design process involving designers and university stakeholders is currently in place at Penn. The *ELSP* proposes expanding this process to better support ecological maintenance practices within existing and future campus landscapes.

As the campus shifts towards a more ecological landscape, the general approach toward maintenance practices on campus will need to become more nuanced and responsive. Time intensive tasks, such as lawn mowing, trash pickup, and leaf clean up, must be balanced with a greater degree of invasive species control, plant-community enrichment, and monitoring of plant health.

Maintenance currently functions within a top-down administrative structure, which is efficient for large scale tasks but limits flexibility. The *ELSP* recommends a shift toward Adaptive Management, giving groundskeepers appropriate agency to monitor and manage complex landscapes.

Adjustments to maintenance teams' administrative structure will provide groundskeepers greater ownership of their work. A new "Skilled Gardener" position within the crews is proposed to implement and maintain the Adaptive Management approach. The Skilled Gardeners could each take responsibility for a particular zone within Penn's campus, accumulating intimate knowledge of their assigned landscape and providing leadership to other crew members. This new role could help Penn motivate and maintain the necessary knowledgeable horticultural staff and enrich the career ladder for such work.

Examples of Penn's environmental leadership are well communicated through various forms of engagement with students, staff, alumni, donors and professional communities. This allows Penn to expand its environmental impact by inspiring other campuses and communities to adopt similar practices. Integrating Penn's enhanced stewardship efforts into this outreach will spread an appreciation of the ecological landscape, its value, and its aesthetic.

## ORGANIZATION OF THE REPORT

The first chapter describes the origins, objectives, and initial findings of the *ELSP*. In the second chapter, the *ELSP* analyzes the study's findings and identifies opportunities to enhance the ecological value of Penn's campus and maintenance practices. The third chapter puts forth recommendations organized from the four perspectives of design, maintenance, administration, and outreach. The Appendix features research, notes, data, specifications, and programs for further reading.

## CONCLUSION

As Penn continues to examine and plan for the future of its landscapes, the understanding of sustainable practices is evolving. Systems that were once engineered and regulated through strict regimens of chemicals and other traditional management techniques are now being transformed into landscapes that favor healthy and robust ecosystems. These ecological landscapes both contribute to and gain strength from local and regional systems. Establishing such systems requires a fresh approach to land management, and the ***ELSP*** identifies the next steps toward achieving Penn's goal of enhancing and enriching its ecological approaches to landscape stewardship.

# Chapter 1

## *PRESCIENT PAST, PROMISING FUTURE*

From leafy enclaves to verdant fields, the University of Pennsylvania's West Philadelphia campus comprises an urban oasis. Benefiting from the vision of its founders, the campus grounds provide an iconic backdrop to a prominent and influential research institution. ***The Ecological Landscape Stewardship Plan (ELSP)*** is intended to ensure the continuity of the character of Penn's open space while reinforcing the university's role as a pioneering environmental leader.

Achieving a beautiful urban ecological landscape – one that supports the native ecology of the site and the region – requires appropriate design and long-term care decisions. Through such considerations, the *ELSP* describes how the commonly-accepted aesthetic of the Penn landscape can evolve into one that reflects more biological diversity and ecological richness. An ecological landscape optimizes the function and success of the natural resources on site and allows native ecology to have a more prominent presence. It utilizes a diversity of native plant species to provide food and shelter for native birds and insects and adapts to variations in environmental conditions. By being less consumptive and more regenerative, ecological landscapes minimize the use of renewable resources and reduce waste and pollution.

Nationally, a greater focus on the significant benefits and functions of urban ecosystems has evolved. Urban landscapes can provide ecosystem services, including climate regulation, nutrient regulation, maintenance of genetic diversity, pollination, pest regulation and seed dispersal (Bolund and Hunhammar, 1999). Landscapes also need improved resilience to the current and future pressures of climate change and resource limitations. At Penn, a desire exists to enhance landscapes that provide multiple benefits to the environment, contribute to biodiversity, improve water quality, and minimize and offset carbon emissions.

## HISTORY OF SUSTAINABILITY ON CAMPUS

The campus has evolved over 140 years, from a few buildings on a rural five-acre site to a cohesive 300-acre urban campus with hundreds of buildings and miles of streets and walks. The campus landscape – serving as a the fabric between buildings as well as a link to the larger city – functions as a large, complex, urban park with 100 acres of open space, a canopy of nearly 7,000 trees, and a unique collection of walks, plazas, and gardens.

In the 1950's, when the trustees and the City of Philadelphia buried the trolley system that served West Philadelphia beneath the campus, a new appreciation for open space emerged. This inspired the establishment of major walks along former roadbeds, open lawns, extensive gardens, and the planting of hundreds of trees. As early as 1956, the attention to stormwater runoff, native plant material, and the salvage and re-use of paving stones served as a precursor to Penn's current environmental approach to development.

Many notable landscape architects and planners from Penn's faculty, such as Sir Peter Shepheard, Ian McHarg, Laurie Olin, Bob Hanna, Carol and Colin Franklin, and Leslie and Rolf Sauer, guided and set the standard for the unique campus character. The *Landscape Development Plan* (*LAMP*) was developed in 1977 and established both design and environmental principles still in use today.

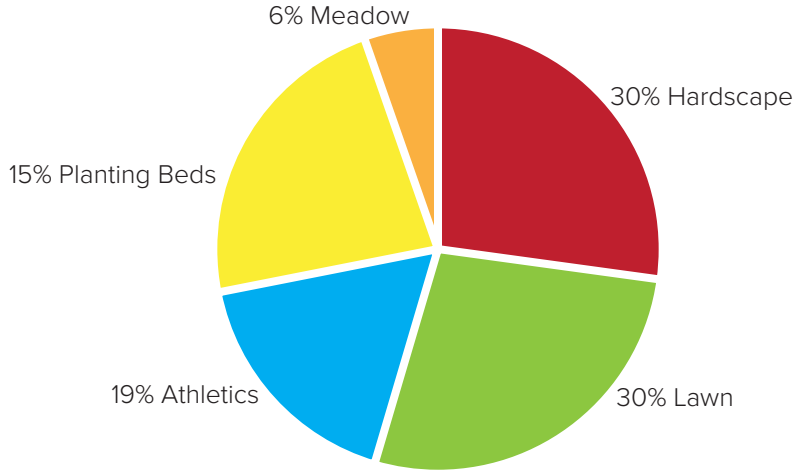



***Figure 1.1 - Types of Open Space on Campus***

In 2007, Penn President Dr. Amy Gutmann signed the American College and University Presidents' Climate Commitment, a nationwide initiative to advance environmentally-friendly practices at institutions of higher education to combat climate change. Penn developed its *Climate Action Plan* in 2009 to identify targets and establish a process for advancing that commitment.

In 2012, Penn participated in the Sustainable SITES Pilot Program with the creation of Shoemaker Green. SITES, an interdisciplinary

partnership of the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center at The University of Texas at Austin, and the U.S. Botanic Garden, was developed to help design and measure landscapes to enhance their environmental value. An important feature of the SITES program was its emphasis on management practices, through which it went well beyond the design and construction focus of the LEED system for buildings. Through Shoemaker Green, Penn has already monitored and tested ecologically-based management and stewardship on a small scale.

A true 'urban forest,' the campus' rich character was officially recognized in January 2017 by ArbNet Arboretum Accreditation Program, which designated the campus as an arboretum — one of only twenty-three in the world and the only one from the Ivy League. This new classification, in addition to eight consecutive years of *Tree Campus USA* designation from the Arbor Day Foundation, clearly celebrates Penn's commitment to environmental principles. It acknowledges an emphasis on the preservation of mature canopy trees, which perform ecological services far exceeding those of younger, smaller trees.

Additional initiatives across the campus have included meadow establishment protocols in Penn Park and city street corridors and the development of gardens designed to attract native pollinators. The introduction of native perennials is replacing some annual flowers that need to be replanted every year. Stormwater management was incorporated throughout the campus. For each rain event, Penn now has the capacity to collect over 330,000 gallons of stormwater for irrigation reuse or infiltration and has installed almost an acre of green roofs. Penn is also working to reduce the amount of chemicals in the environment by incorporating compost tea and integrated pest management practices.

By 2014, Penn published its updated report, the *Climate Action Plan 2.0*, to continue building on successes and learning from obstacles. The "Physical Environment" section of that document outlines a mission to "create and maintain a sustainable campus by increasing ecologically-managed green space, decreasing building energy consumption, and increasing education and awareness of sustainable design."

The *Climate Action Plan 2.0* included the following strategies for promoting ecological landscapes:

i. Strongly encourage, maintain, and respect existing urban forest during construction projects.
ii. Revise design guidelines and landscape standards so that new landscape projects will have no more than 10 percent of any one species, 20 percent of any one genus, or 30 percent of any family.
iii. Improve natural habitats for native flora and fauna.
iv. Explore implementation of advanced glazing on all new and renovated structures to reduce bird strikes and protect native species.

**OBJECTIVES**

Penn's campus landscape provides an informal place of learning for an influential body of faculty, students, and staff. As such, the campus serves as a high-profile showcase for its many environmental initiatives. The *ELSP* seeks to extend these efforts into the field of ecological landscape management and ultimately

spread awareness to a larger community. It also strives to enhance Penn's existing environmentally-minded landscape practices by formalizing a holistic management approach. It addresses a series of complex urban environments and ecosystems by examining soil biology, biodiversity, hydrology, arboriculture, cultural practices, turf quality, labor, mechanical equipment and aesthetic expectations in order to promote a healthy and resilient campus landscape.

The goals of the ***ELSP*** include:

- Enhancing the ecological contributions of the campus landscape
- Reducing waste and pollution created during campus maintenance
- Maintaining a high aesthetic standard for the campus landscape
- Educating the community at large about ecological stewardship

In order to achieve these goals, the following objectives were identified:

- Develop a management plan for existing landscape typologies.
- Provide campus-wide best practices in landscape maintenance.
- Create performance strategies that help Penn enact change.

## METHODOLOGY

The ***ELSP*** was generated using a process of both observation and open dialogue with Penn. The consulting team conducted site evaluations, held stakeholder meetings, and reviewed research materials, past studies, existing maintenance strategies, and standing design guidelines from Penn. Detailed notes from these site evaluations and meetings are included as supplements to this document. Throughout the process, the consulting team collaborated with Penn to identify themes and develop feasible recommendations.

Site evaluations of the four pilot sites ***(See Figure 1.2)*** occurred each season to observe maintenance practices and allow the team to assess the effect that the academic calendar has on landscape conditions. Observations pertaining to biodiversity, plant health, soil health, and stormwater management were balanced against the apparent design intent of the space. These observations were supplemented with anecdotal reports from maintenance crews and facilities staff.

Stakeholder meetings allowed the consulting team to understand Penn's maintenance practices and perceptions. The meetings were held between site evaluations, enabling the team to share observations, ask questions and test recommendations as they emerged.

These observations highlighted opportunities for improving maintenance protocols, empowering staff, expanding expertise and enhancing coordination between various parties. Based on these opportunities, the ***ELSP*** outlines design, maintenance, and administrative initiatives to better support an ecological landscape.

As with any approach to systemic management changes, this study suggests transitional measures to help reduce down time, conserve resources, and implement gradual modifications to Penn's current management regimen. This includes longer-term implementation actions and further suggested studies.

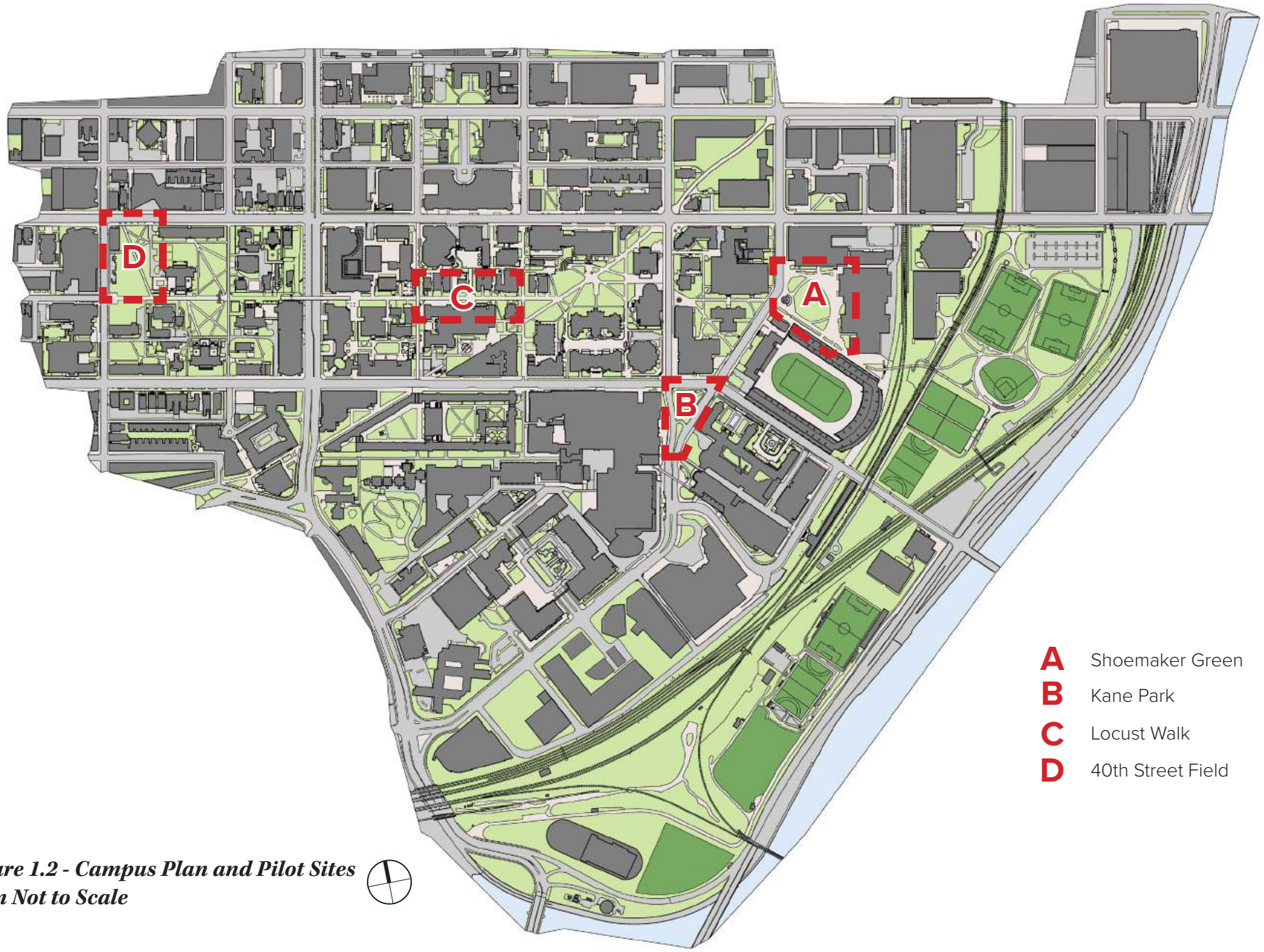



***Figure 1.2 - Campus Plan and Pilot Sites***
***Plan Not to Scale***

## LANDSCAPE TYPOLOGIES

The four pilot sites selected for this study reflect a diversity of design, management, use, and programming. Each site is representative of a landscape typology found on Penn's Campus: the Sustainable SITES Pilot Program (Shoemaker Green), the campus park (Kane Park), the signature walk (Locust Walk), and the active public park (40th Street Field).

Each of these spaces carries the aesthetic expectations of Penn's campus. They are also subject to ongoing stress from constant foot traffic, special events, litter, bike parking, and winter snow removal. As an open campus nestled into the urban landscape, Penn experiences basic public-use concerns for these spaces as well. Factors such as visibility, security and clarity of function must play an integral role as Penn considers its approach to landscape stewardship.

## SHOEMAKER GREEN - THE SUSTAINABLE SITES PILOT PROGRAM

Shoemaker Green represents a new approach to campus spaces through its development of a high-performance landscape, in accordance with the goals of the Sustainable SITES Initiative. Constructed in 2012, the park acts as a new public commons for existing iconic buildings.

- Location: 33rd Street between Spruce and Walnut streets; adjacent to the David Rittenhouse Laboratory and four sports venues – Franklin Field, the Palestra, Hutchinson Gymnasium, and Penn Park – at the eastern edge of the main campus

- Size: 2.75 acres

- Primary users: Penn community and visitors to the sporting venues

- Physical elements: A large central green, pathways, plaza space, garden beds featuring native plantings, mature trees preserved during construction, a large rain garden and stormwater cistern

- Activities: Primarily used for passive recreation but also hosts large special events throughout the year


***Figure 1.3 - Shoemaker Green - Plan Not to Scale***


***Figure 1.4 - Kane Park - Plan Not to Scale***

## KANE PARK - THE CAMPUS PARK

Kane Park was selected for this study to serve as a model campus park. It serves as both a retreat for hospital visitors and staff and a visual gateway connecting the academic core of campus with that of the Penn Health System.

- Location: At the junction of 33rd, 34th, and Spruce streets; between the Penn Health System and the southeastern edge of the university's main campus
- Size: .5 acres
- Primary users: Hospital staff, visitors, and the general public
- Physical elements: Landscape beds featuring largely native plants, permeable pavement, benches along secondary pathways, small central lawn space
- Activities: Commonly used for taking breaks or eating; perimeter path along Spruce Street serves mainly as a connector.

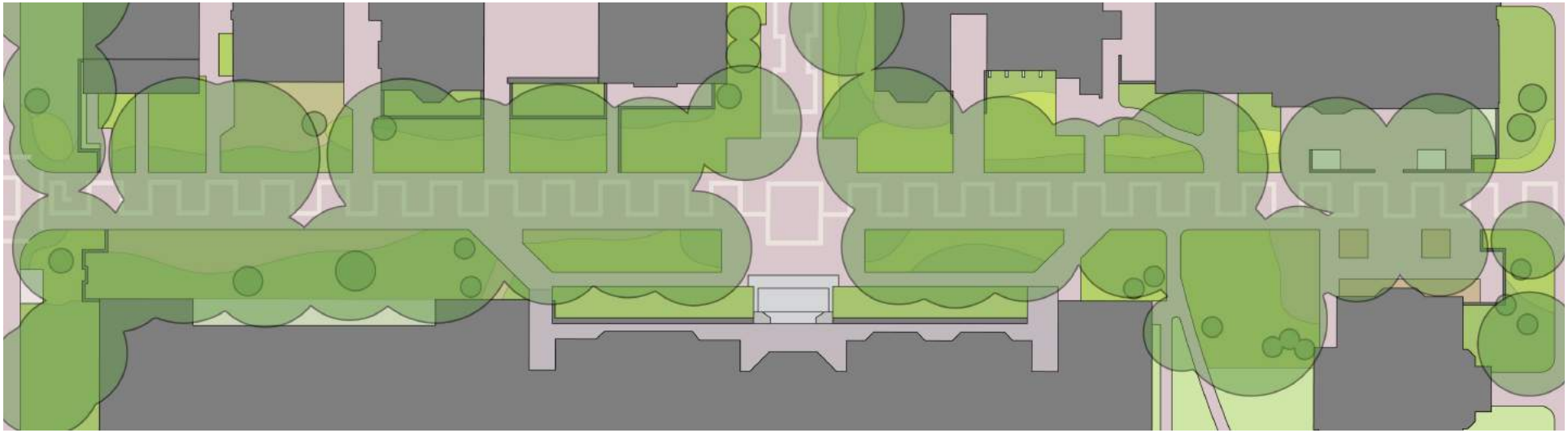


*Figure 1.5 - Locust Walk - Plan Not to Scale*

## LOCUST WALK - THE SIGNATURE WALK

Locust Walk is the iconic landscape of Penn and serves as its major pedestrian artery. It is also a historic landscape that is used heavily daily and during special events. This study focuses on a single block of the larger walk.

- Location: Locust Walk between 36th and 37th streets, in the core of the campus
- Size: 1 acre (Study Area)
- Primary users: Penn community
- Physical elements: Paved walkway lined by large mature trees and shady landscape beds; beds separate the paths from university buildings and fraternities
- Activities: Primarily used as a pedestrian pathway through campus; major destination for student body clubs and societies


***Figure 1.6 - 40th Street Field - Plan Not to Scale***

## 40TH STREET FIELD - THE ACTIVE PUBLIC SPACE

The field at 40th Street is a utilitarian landscape that features an informal playing field and pathways that connect the campus to the public. Within the ***ELSP***, it is representative of other campus fields.

- Location: Between Locust Walk and Walnut Street on the corner of 40th Street; at the northwest corner of the campus and the western end of Locust Walk
- Size: 1.8 Acres
- Primary users: Both the Penn community and the surrounding West Philadelphia neighborhoods
- Physical elements: A central active lawn space; a heavily canopied perimeter; secondary and tertiary pedestrian paths that connect Locust Walk to the nearby streets
- Activities: Heavily used for informal sporting, student activities, and community programming

# Chapter 2
## *FINDINGS & RECOMMENDATIONS*

Through this study, Penn is striving to make its campus a model for ecological stewardship as part of the broad aspirations of its *Climate Action Plan*. A critical component to achieving that goal requires understanding the existing conditions on and around the campus, acknowledging current and evolving perceptions of beauty, and considering the design of spaces and maintenance practices. The findings explored in this section will contribute to the development of broader recommendations in Chapter 3.

### REGIONAL CONTEXT

The City of Philadelphia exists within a regional, ecological matrix of interconnected forest, open space, and waterways that provide a critical foundation for habitat patches and corridors for various species and communities. The city lies between the Schuylkill and the Delaware rivers, major corridors along the Atlantic Coast that provide an important stopover for many migratory birds along the Atlantic Flyway. Public open spaces and waterways in the region provide valuable opportunities to support myriad native plant and wildlife species.

The University of Pennsylvania is situated along the western bank of the Schuylkill River. In the immediate vicinity of the campus, a number of green spaces act as habitat patches, including the nearby Woodland Cemetery and Schuylkill River Park (***See Figure 2.1***). In the broader landscape context, the campus lies within an urban mosaic punctuated by green space and small habitat patches, including Cobbs Creek, Bartram's Gardens, and Fairmount Park.

Strengthening the campus landscape's native ecological function benefits both the local and regional environments. Given the location of the campus, an opportunity exists to more fully connect to the larger ecosystem. This includes the creation of habitat for birds, insects, other pollinators, small mammals, amphibians, and reptiles to thrive. In its commitment to improving the local ecology, Penn is contributing to the strength of the native regional ecology as well as people, health, and wellness.

## SITE- SPECIFIC CONDITIONS AND OPPORTUNITIES

Over the course of a year, the four selected research sites were examined with a focus on landscape ecology and maintenance practices. This section reviews each research site from the perspective of its design intent, biodiversity, plant health, soils, and stormwater management. Each of these areas is assessed and opportunities to improve the landscape ecology and stewardship practices are identified.

*Design intent* describes the function of the space within the social fabric of the campus. It considers the site's intended activities, user groups and aesthetic expectations. The ecological components of any given space should fit within the narrative of the design intent.

*Biodiversity* includes an analysis of both structural diversity and species diversity. Structural diversity considers the presence of the following vegetative layers: ground covers, perennials, shrubs, understory trees, and canopy trees. Species diversity refers to the total number of unique plant species within the site. The *ELSP* identifies opportunities to increase both kinds of biodiversity in order to improve the resilience of the landscape and its contribution to native habitat.

*Plant health* considers the health of the plant communities within the site. Poor plant health and performance may be indicated by signs of stress or disease and may be caused by poor siting, physical damage, or detrimental maintenance practices. Evaluation of the health of a plant community also considers the presence of invasive species, aggressive plants of low ecological value that out-compete desirable species.

*Soils* were analyzed to understand soil structure, pH, and the presence of beneficial organisms. An understanding of the soil's texture, nutrient levels, and pH can provide clues for improving plant health and stormwater infiltration. The presence of beneficial organisms not only contributes to plant health but also signals a plant's ability to uptake and regulate nutrients in the soil.

*Stormwater* was reviewed to understand flow across the site, infiltration, collection, or runoff into the combined sewer system. Opportunities to increase infiltration or stormwater collection were sought as a means of decreasing runoff-based pollution of the Schuylkill River. The stormwater recommendations within the ***ELSP*** reiterate or compliment Penn's ***Stormwater Master Plan***, which proposes stormwater enhancements campus wide.

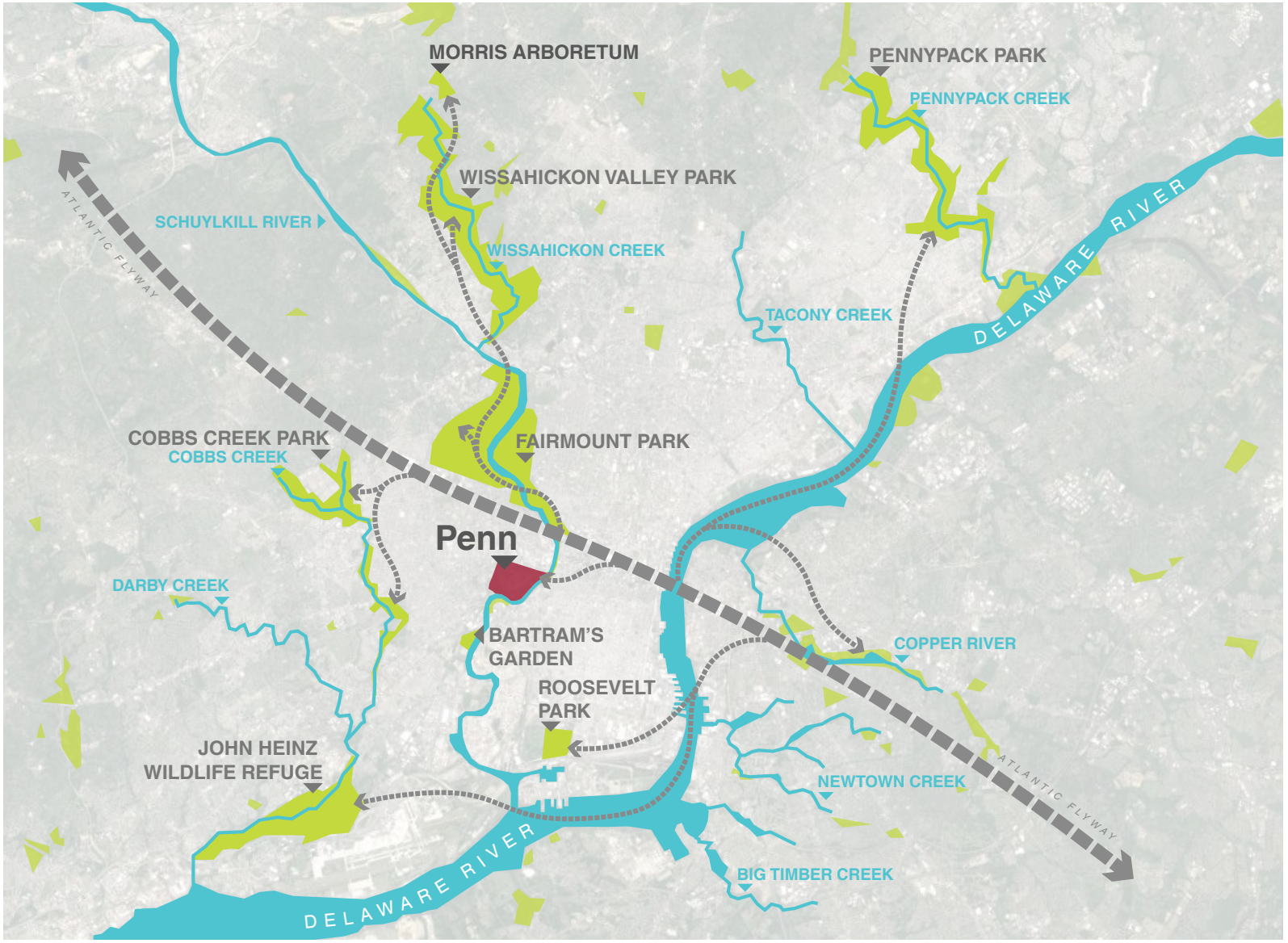



***Figure 2.1 - Landscape Ecological Connections***

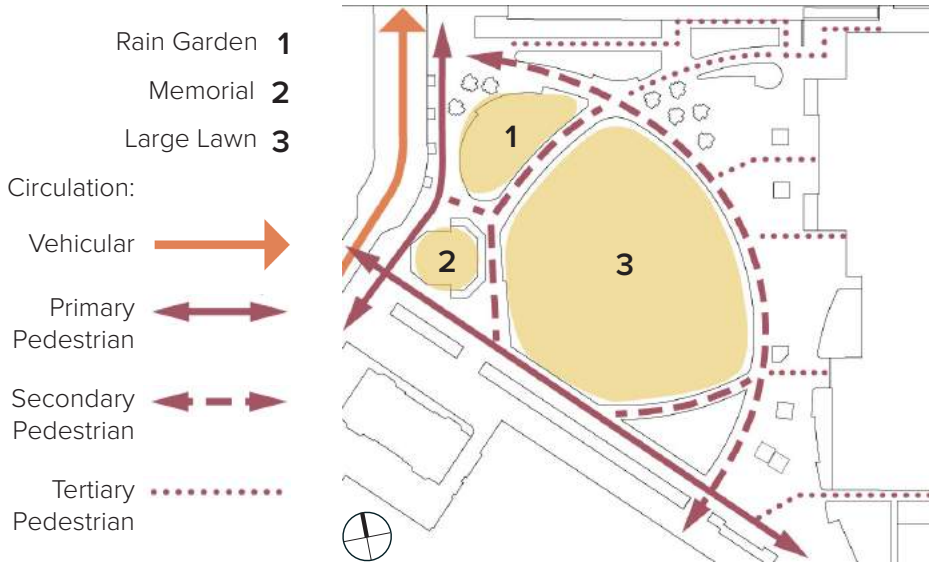



*Figure 2.2 - Shoemaker Green Design Intent*

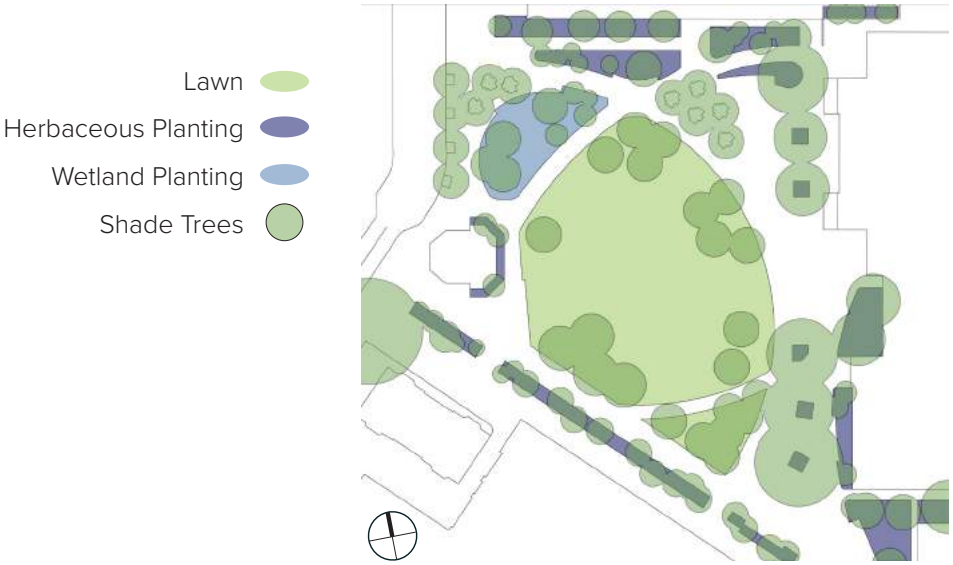



*Figure 2.3 - Shoemaker Green Planting Types*

## SHOEMAKER GREEN

*Design Intent* – Shoemaker Green was designed as a new public commons with spaces complementing the existing buildings and surrounding circulation. Previously occupied by tennis courts, the site can now accommodate a variety of activities, boosting its social and ecological value to the campus. A large central lawn provides ample space for passive recreation as well as visual open space next to iconic stadium and heavily used academic buildings. Beds line the walkways and give framework to the circulation. A large rain garden adjacent to the street offers visual interest, creates habitat, manages stormwater, and separates the plaza from the very active 33rd Street.

As a pilot project for the Sustainable SITES Initiative, Shoemaker Green maximizes the environmental and ecological functions of an urban landscape. The space also introduces a new hybrid aesthetic, providing traditional landscape elements, while presenting more naturalized plantings within the rain garden.

*Biodiversity* – Shoemaker Green boasts a variety of successful planting types, including lawn, herbaceous planting beds, and wetlands. The canopy layer at Shoemaker Green features both mature and newly-planted native trees, offering a variety in species and ages. Herbaceous beds and wetlands feature a diverse species mix of native canopy trees, shrubs, and perennials. This variety creates a multitude of ecological benefits and serves as a strong example for the larger campus.

*Plant Health* - The canopy's mature London Plane trees *(Platanus × hispanica)* were well-protected though the park's construction and have continued to thrive. The vigilant protection measures

used to preserve these trees should be repeated elsewhere on campus to ensure the continuity of Penn's valuable, high-performing canopy.

On the ground, perennial die-off has occurred in some of the beds, which seemed to stem from two different causes: trampling from users and some initial irrigation problems that have since been resolved. Penn Relays events are concentrated around Shoemaker Green, and although fencing gets erected around certain beds and the lawn, unprotected areas experience trampling, decreasing the survival of ground covers. In later evaluations, bike racks and other movable elements were found in the beds, hindering the establishment of perennials, which provide valuable coverage and increase biodiversity. Because the beds are appropriately sited and planted, plants should be replaced at Shoemaker Green when they die and should be better protected from trampling.

In the rain garden, excessive mulching was preventing the ground cover from spreading and impeding performance of the stormwater system. By familiarizing grounds crews with the new system's maintenance requirements during the hand-off process, such problems could be avoided.

Invasive plants were largely under control, with scattered populations of Foxtail *(Setaria viridis)* in the rain garden and a patch of Goutweed *(Aegopodium podagraria)* within one of the beds, which has since been removed. Increasing the density of the native ground cover would help further limit the spread of these weeds, which could be achieved by reducing mulching and planting supplemental perennials within bare areas. Groundskeepers could benefit from more education on species

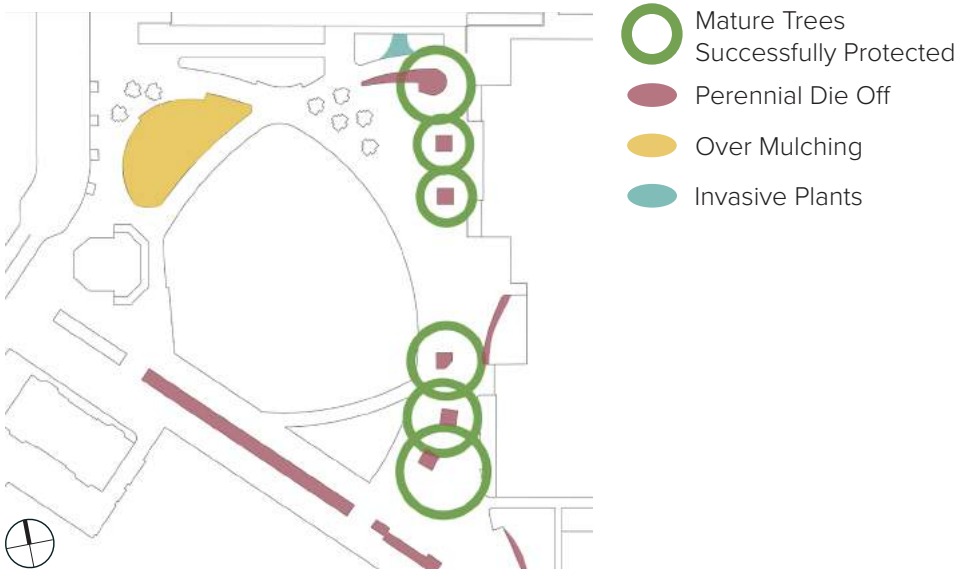



***Figure 2.4 - Shoemaker Green Plant Health***

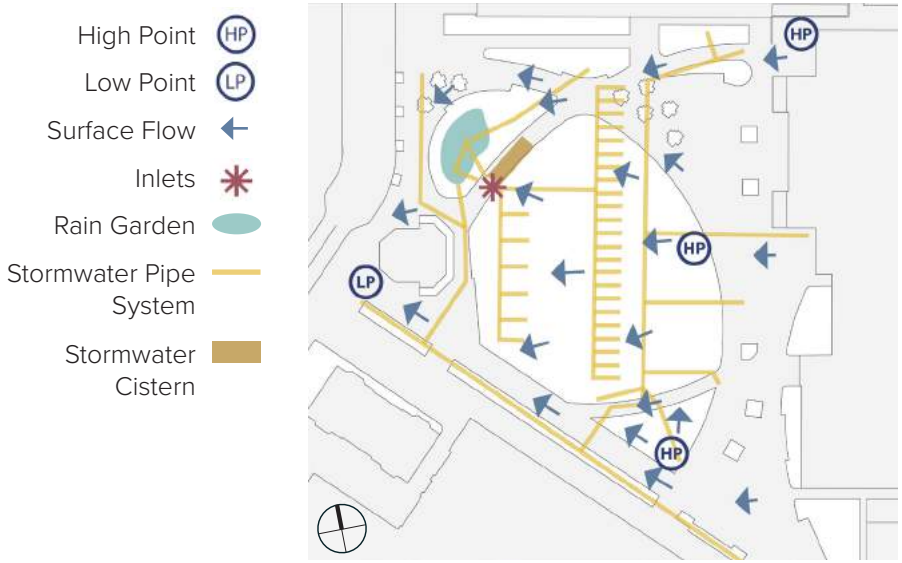



***Figure 2.5 - Shoemaker Green Stormwater***

identification, especially where invasive weeds may appear very similar to the intended species.

*Soils* - As an expansion of Penn's SITES designation, Penn, along with students, faculty, and external partners, continue to use Shoemaker Green as a living laboratory, collecting data on how well the green infrastructure is working. This includes ongoing monitoring of the soils in various areas, which has been maintained at a high level of health through applications of compost tea in lawn areas and the establishment of healthy plant communities in the rain garden and Perennials beds.

The ***ELSP*** soils sample was taken from the lawn area, which utilizes an engineered soil designed to withstand heavy foot traffic and function as a component of the stormwater system. This sample had low organic matter and a low available water capacity, which was expected from a heavily sand based soil designed to withstand compaction and encourage infiltration. Despite the pressure from large activities held at this location, no significant compaction problems were observed within the lawn or planting beds. The soil health analysis indicated high root pathogen pressure and low soil respiration, both of which are indicators of an imbalanced soil microbial community. This can be countered to some extent by further applications of compost tea. Where possible, replacing lawn grasses with a diversity of ground-cover plantings could more substantially improve the soil's microbial activity through the deeper root structures and complimentary microorganisms associated with native perennial species.

*Stormwater* – Shoemaker Green proves how Stormwater Management Practices (SMPs) can be integrated seamlessly into the campus landscape. The site features a bioretention facility,

permeable paving, and an underground storage cistern. Also, mature trees, like the London Plane trees carefully preserved during the construction of this site, provide important stormwater management benefits by helping to reduce runoff and absorbing tremendous quantities of groundwater.

Although the rain garden has operated efficiently, instances of standing water were observed within the basin during multiple site evaluations. This raised concerns about the function of the rain garden, its ability to properly absorb stormwater, and potential problems with mosquitoes. (It was discovered during the course of the study that the irrigation system was being overused due to a miscommunication. Monitoring of this system has since improved, resolving the problem of standing water.)

## KANE PARK

*Design Intent* – Kane Park is a destination green space featuring paths for pedestrians, a small lawn focal point, and a combination of native and ornamental plantings. Previously a parking lot, this space is surrounded by roadways, and the plantings act as a buffer for the internal path system. In addition, the planting style, featuring large swaths of seasonal colors, is attractive and highly visible to both foot and vehicular traffic.

*Biodiversity* - Kane Park features relatively diverse plantings, reflecting a mixed palette of largely native shrubs, perennials, and ground cover. It contains a good balance of canopy and understory, which offers a variety of habitat. Although the lawn anchors the design of the space, a native ground cover could meet design intent and contribute more to Penn's ecological goals.

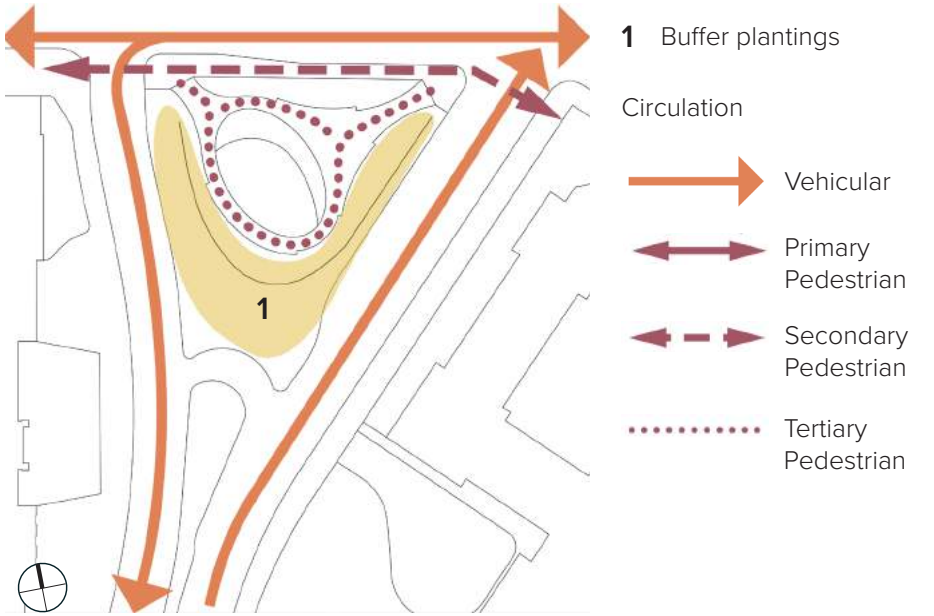



***Figure 2.6 - Kane Park Design Intent***


***Figure 2.7 - Kane Park Planting Types***

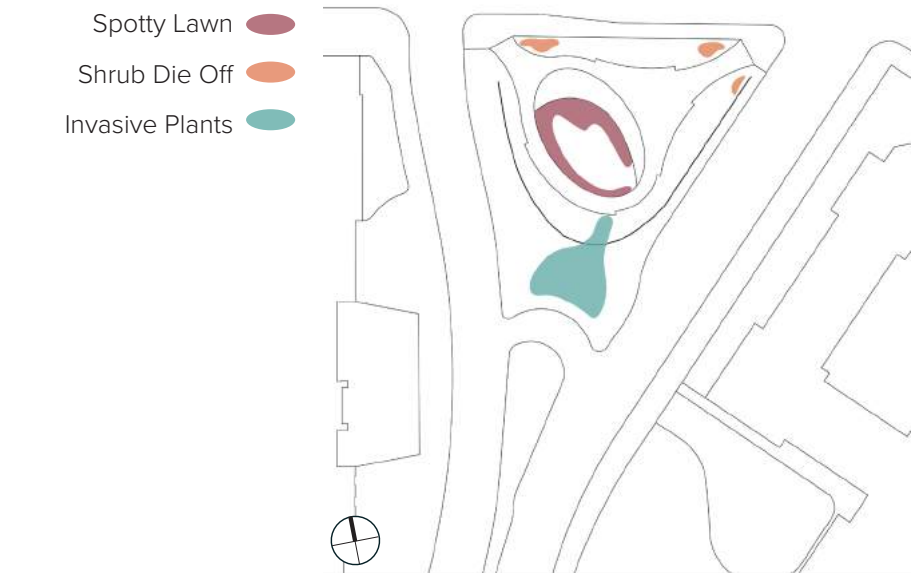



***Figure 2.8- Kane Park Plant Health***

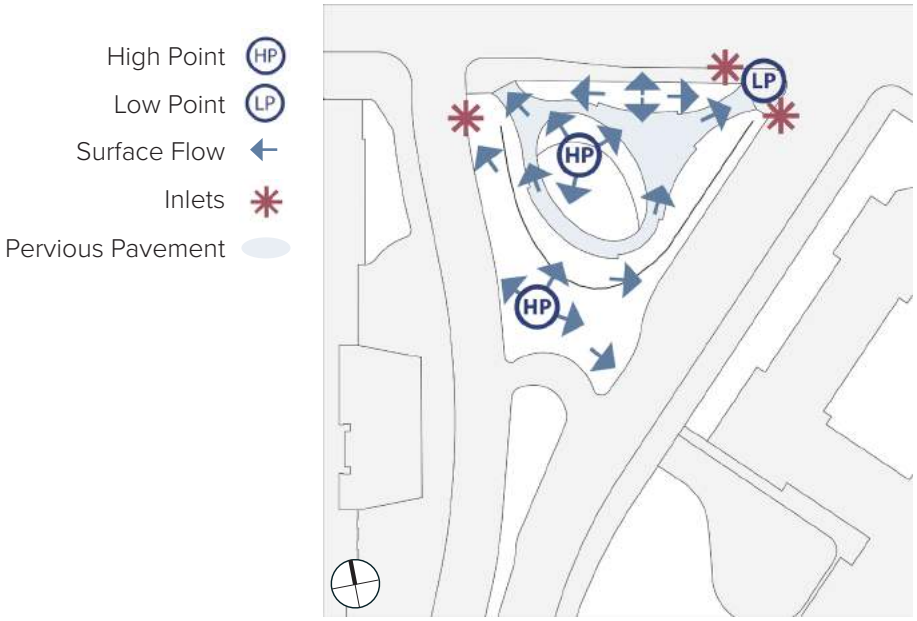



***Figure 2.9 - Kane Park Stormwater***

*Plant Health* – Kane Park's canopy trees were in good health, but some shrubs showed signs of a fungal disease. Symptoms of disease first appeared on newly planted Inkberries *(Ilex glabra),* eventually spreading to nearby established plants, so it is suspected that diseased plants were brought in from the nursery. Also, some of the perennial beds had bare areas where plant species had been poorly selected for site conditions or where mulch prevented the spread of desirable vigorous species, situations that could be easily corrected. The lawn appeared patchy and struggled with weed competition.

In a number of locations, colonies of invasive species have been observed. Given the site's location near fast-moving traffic and some patches lacking extensive groundcover, weeding of these beds is difficult. Maintenance staff also noted that control of one particularly prevalent invasive plant, Canada Thistle (*Cirsium arvense*), has been especially challenging. Discussions with crew indicated that these infestations couldn't be addressed when they first appeared, as crews were tied up with extensive mulching efforts across campus in mid-spring. A more timely and consistent effort toward invasive control –and perhaps the judicious use of herbicide where invasive colonies have progressed beyond a manageable level – could bring these beds back under control.

*Soil* - Kane Park's soils have a loamy sand texture with adequate organic matter. Suboptimal soil characteristics included minor compaction and low available water holding capacity. Constraints also include high root pathogen pressure and low soil respiration, both of which are indicators of an imbalanced soil microbial community. A richer and more layered planting providing shade and more extensive root growth would contribute to a healthier soil biology. In the short term, applications of compost tea can give the

soil health a boost.

*Stormwater* - Kane Park was designed to absorb stormwater via pervious pavement and planting beds. Although no flooding was observed on the site, cigarette butts, sediment, and other debris are slowly clogging the pervious pavement. Regular maintenance through vacuuming pavers and occasionally replacing joint material is needed to perpetuate the functioning of the stormwater system.

## LOCUST WALK

*Design Intent* - Locust Walk is an iconic space on campus that features a large pedestrian thoroughfare framed by arching trees and university buildings. Although other portions of the walk have more porosity, the block studied in this report is very dense and extremely active. Likely the most active open space on campus, it provides a valuable, high-visibility backdrop for Penn as well as an excellent opportunity to promote landscape ecology with a focus on seasonal accents. Critical seasons in this space include spring for Commencement ceremonies and fall for Homecoming and Family Weekend.

*Biodiversity* - Locust Walk is dominated by an Asian-origin tree species, *Zelkova serrata*, but the understory contains a diverse palette of ornamentals as well as native shrubs and herbaceous materials. An opportunity exists to introduce additional native shrubs and herbaceous plants to create a more stratified environment that would contribute to habitat. The University Landscape Architect and Urban Park have worked together to introduce more diversity in the ground plane layer, which now features a variety of hardy perennials. The plantings should continue to be enriched with more native species. In the long term,

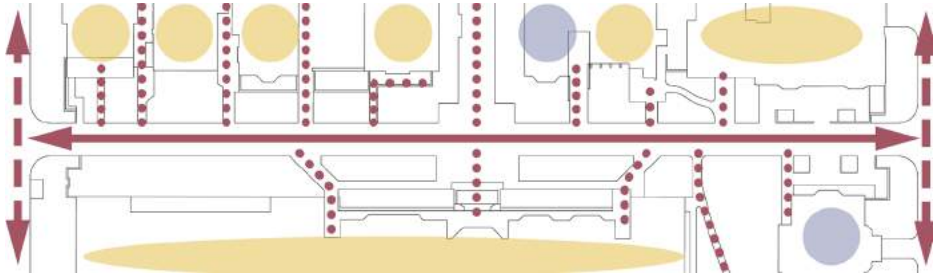


***Figure 2.10- Locust Walk Design Intent***

Academic Building
Resident Buildings
Primary Pedestrian
Secondary Pedestrian
Tertiary Pedestrian

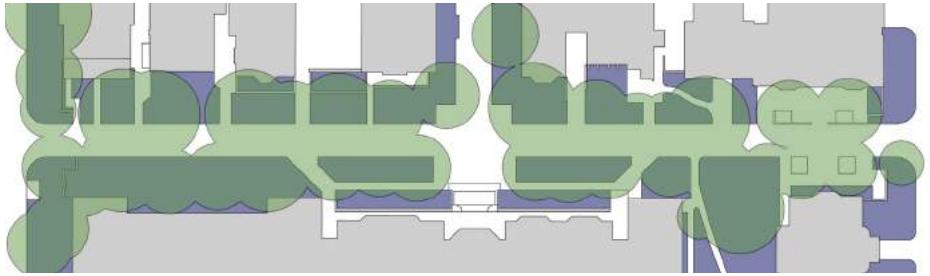


***Figure 2.11- Locust Walk Planting Types***

Shade Trees
Herbaceous Planting

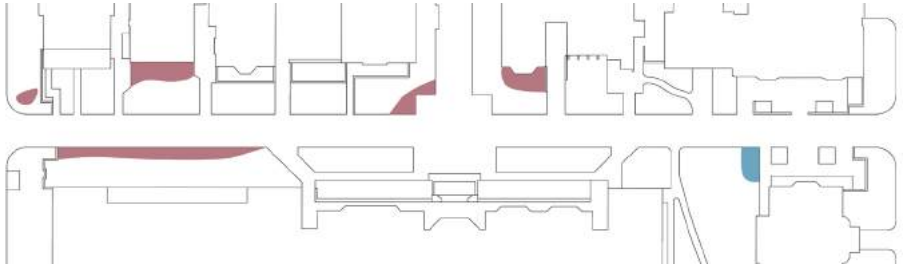


***Figure 2.12 - Locust Walk Plant Health***

Perennial Die off from Trampling

Perennial Die off from Underground Steam

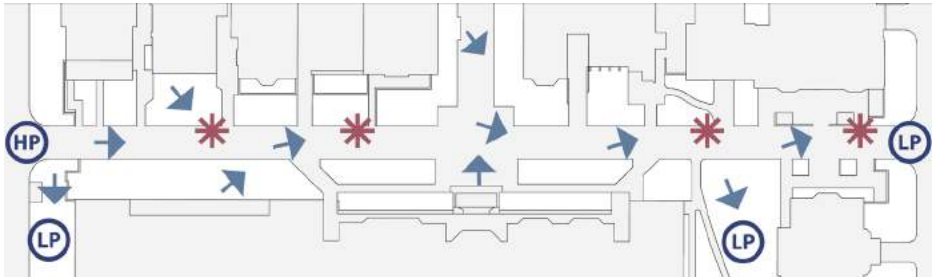



***Figure 2.13 - Locust Walk Stormwater***

HP High Point

LP Low Point

Surface Flow

Inlets

a chance to introduce a greater diversity of native tree species within the canopy layer may exist as well, but this ecological goal needs to be balanced with the aesthetic intent of Locust Walk.

*Plant Health* – The canopy trees are healthy and at peak maturity; however, because the canopy constitutes a monoculture with trees of all the same age, Penn should consider a replacement strategy (See Appendix A). The trees provide a critical feature of the design of the space and the health of the shade-loving species beneath them. Root competition caused by the trees is also a major challenge and must be considered when planning future plantings.

Within planting beds, foot traffic and staging for construction has resulted in erosion and trampling of plants, which has interrupted the establishment of a healthy ground cover. Grounds crews have tried a variety of native ground-cover species that would have otherwise been successful, but better protection of the landscape is necessary for the success of these plantings.

*Soils* - Locust Walk has a sandy loam texture, adequate available water capacity, adequate organic matter in the topsoil, no signs of compaction, and a diversity of plants. The soil health analysis indicated suboptimal functioning for root pathogen pressure, an indicator of an imbalance of disease-causing and disease-suppressing soil organisms. A richer understory planting would support a higher-functioning soil biology.

*Stormwater* - Stormwater on Locust Walk is currently managed by inlets. Although no issues with flooding or erosion were observed, future stormwater management techniques could encourage more infiltration. The large mature trees on Locust Walk also serve a major stormwater benefit. These benefits could be memorialized with other mature trees around campus, as noted in Penn's March 2013 *Stormwater Master Plan*.

## 40TH STREET FIELD

*Design Intent* – 40th Street Field features a large open space often used for informal, active recreation. While highly valued for its social functions, this lawn is less visually prominent or ceremonial than the lawn at Shoemaker Green. Linear pedestrian paths border the lawn and connect corner entries to the space. A bosque of canopy trees lines the eastern side of the space. Students and the public use the central lawn space and paths heavily.

*Biodiversity* - This site is limited in structural diversity, dominated by turf and canopy trees. The canopy trees represent a modest diversity of species, a little over half of which are native. A healthy diversity of ages is present in the canopy layer, ranging from recent plantings to trees near the end of their life. An opportunity exists to develop an understory tree layer and ground plane herbaceous layer within the underused spaces surrounding the main lawn. This would increase biodiversity without detracting from the site's function.

*Plant Health* – A number of concerns surfaced regarding the health of the canopy trees during the study. Various trees are in decline at 40th Street Field due to having been planted with their trunk flares too low. Such poor planting techniques likely also contributed to the weakening of a number of Sweet Gums *(Liquidambar styraciflua)* that were lost in a storm over the summer during the study. The trunk flares of deeply planted trees were excavated in the spring as a corrective measure, but those excavations were later reversed in the summer when mulch was applied too heavily. A lack of proper tree protection was also noted in the summer and fall evaluations, where contractors working on the Rodin College House were staging equipment

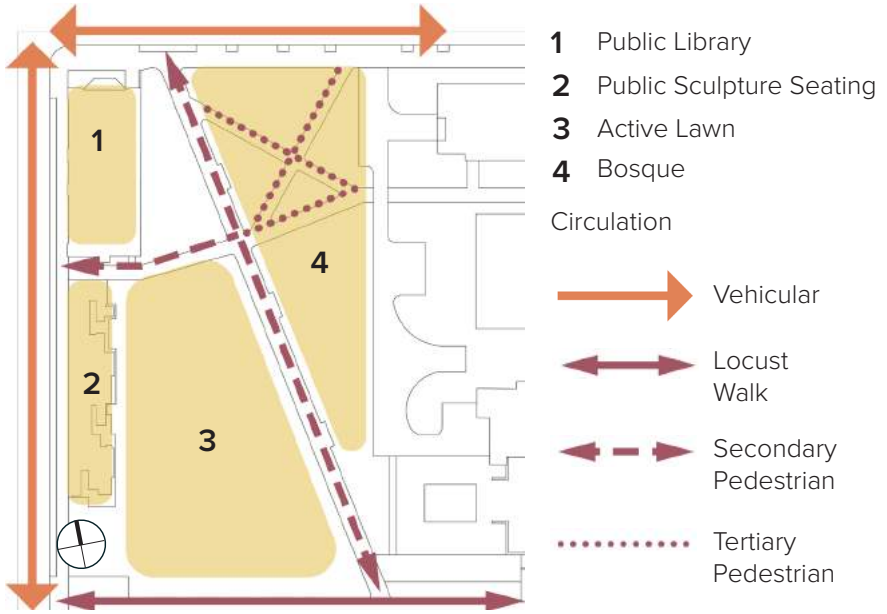



***Figure 2.14 - 40th Street Field Design Intent***


***Figure 2.15 - 40th Street Planting Types***


***Figure 2.16 - 40th Street Field Plant Health***

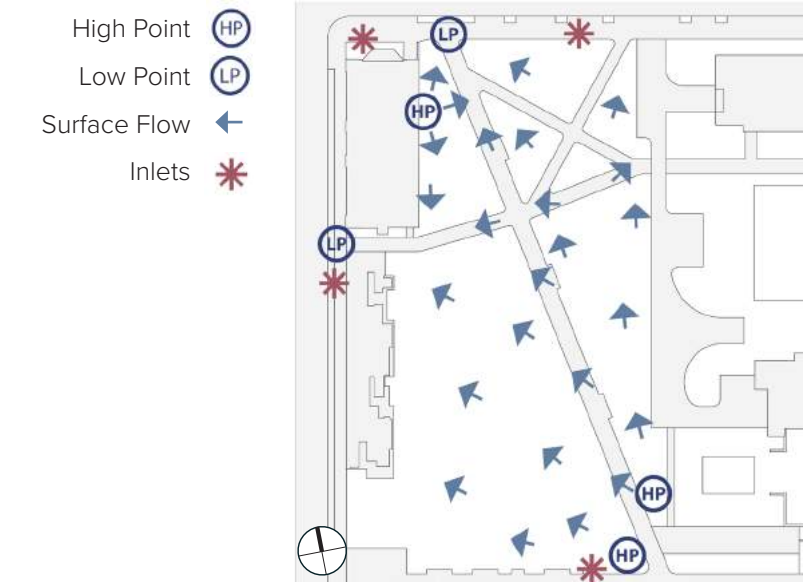



***Figure 2.17- 40th Street Field Stormwater***

within the root zones of canopy trees.

The lawn was observed to be patchy, compacted, and full of invasive species throughout the study. Steps taken to improve the lawn included reseeding efforts, soil amendments, and irrigation during drought, but the lawn's continual heavy use prevented it from ever resting and fully recovering.

Such incidents indicate opportunities for greater accountability in installation, construction, and ongoing and corrective maintenance.

*Soils* - This site features a loam texture with adequate organic matter and available water capacity. Severe compaction was observed, as indicated by sparsely vegetated patches, platy soil structure, and auguring difficulty. Rocks, bricks, and asphalt were all encountered during the soil sampling, supporting speculations that this site was built over the debris of the demolition that is known to have occurred in this location.

High root pathogen pressure, an indicator of an imbalance of disease-causing and disease-suppressing soil organisms, was also present, as determined by soil health analysis. Some of this poor soil biology can be attributed to the extreme dominance of lawn grass. Perennial and shrub plantings added within the underused lawn areas would create a more beneficial soil biology than lawn. Such a plant community would also compete less with tree roots for available water. Within heavily-used lawn areas, periods of rest after reseeding and amendment would allow healthier root structures to develop and contribute to a healthier soil.

*Stormwater* - Stormwater management at 40th Street Field relies on surface flow to inlets on the perimeter of the site. Greater

***Figure 2.18 - High profile iconic lawns, like the central lawn at Shoemaker Green, should remain lawn.***

***Figure 2.19 - Low profile and underutilized lawns should be converted into a richer plant community.***

infiltration would occur through richer plantings or rain gardens at the park perimeter, which would filter pollutants and reduce loads on the city stormwater system. Improving the lawn through amendment, rehabilitation and rest could also improve infiltration.

## OVERALL MAINTENANCE PRACTICES

Campus landscape maintenance includes the following primary activities: lawn care, tree care, perennial bed maintenance, trash pickup, leaf cleanup, composting, snow removal, and upkeep of paved surfaces, irrigation systems, green roofs, and site furnishings. These tasks are performed by several different collective bargaining agreement groups, or CBA's: Grounds Crew (CBA 835), Hard Surfaces Crew (CBA 115), and Brightview, a third-party landscape maintenance contractor. This section explores each of these activities and ways in which they could be modified to enhance sustainability and promote landscape ecology.

*Lawn Care* – The landscape maintenance contractor primarily cares for lawn areas on campus, including regular mowing and fertilizing. The contracting out of lawn care is a business decision based in part on liability, but also on the expense to maintain equipment, flexibility in scheduling of contractors, and possible financial savings on labor. Grounds Crew and Brightview share the responsibilities for string trimming, aeration, top-dressing, and overseeding.

In general, lawn contributes very little to habitat, and its maintenance requires a great deal of resources while contributing to air and water pollution. While a short-term improvement may be to use electric lawn equipment and continue Penn's ban on synthetic fertilizers, a long-term plan should limit the amount of

lawn spaces strictly to those that are heavily utilized. Underutilized lawn spaces could be converted to more ecologically valuable landscape types, such as mixed perennial/shrub beds. Low profile but well used lawns could benefit from more resilient grass mixes, while a small number of high profile, well used lawns could justify higher inputs and more substantial investments. See Appendix A for more detail.

*Tree Care* – Tree care is also handled primarily by Brightview. Pruning work that requires specialized equipment and/ or a specific task related to safety training may be contracted out to a third party at the discretion of management. Tree fertilization and pruning from the ground is handled by both the Grounds Crew and Brightview. Grounds Crew handles mulching of tree rings.

The need for more stringent enforcement of tree protection was also apparent in multiple field observations. For instance, equipment from ongoing construction projects near the 40th Street Field were located within the root zones of mature trees for months throughout the study. In order to preserve valuable existing trees, monitoring could be incorporated into the daily routine of the groundskeepers. Opening up communication between groundskeepers and construction project managers could prevent damage to existing vegetation.

*Perennial Bed Maintenance* – Perennial bed management consists of a number of largely seasonal tasks. Mulching represents a major effort that occurs in the spring over the course of four or five weeks. This task takes the full attention of the Grounds Crew, and, according to groundskeepers, little else occurs during this horticulturally important stretch of time. Weeding, replanting, and other tasks get deferred until this work is complete. The extent

***Figure 2.20 - Tree monitoring is a critical task on Penn's iconic Locust Walk.***

***Figure 2.21 - Large areas of mulching is both time consuming and counterproductive in perennial beds meant to fill with an herbaceous layer.***

***Figure 2.22 - Showy annuals bring interest to Locust Walk.***

***Figure 2.23 - Showy bulbs also provide spring interest and do not require replacement every year.***

and depth of mulch often proved excessive. Dense ground cover planting, like *Aster*, *Liriope*, and *Carex*, received a heavy layer of mulch that prevented them from naturally spreading. By limiting mulch, desirable spreading species can out-compete invasive species on their own.

Grounds Crew performs weeding when other tasks do not take precedence. Consistent with its *Climate Action Plan*, Penn has adopted a policy to reduce herbicide use on campus, which means that weeding efforts must occur almost entirely mechanically. During site observations, some invasive species were found to be at unmanageable levels. In the spring, it was noted that weeding had been deferred due to mulching operations, allowing a number of weeds to gain an early foothold. For example, Canada Thistle *(Cirsium arvense)* identified in the spring in Kane Park had flowered and was setting seed during the summer evaluation.

It was also noted that, despite Penn's restriction on herbicides, areas on Locust Walk and Kane Park showed signs of herbicide application. The evaluation team was unable to determine who had applied the herbicide or what kind it was. In order to maintain a completely herbicide-free policy, weeds need to be prevented from going to seed, and regularly cut back to become starved of nutrients. This effort requires constant monitoring, flexibility, and improved tools. Extreme cases may actually justify herbicide applications to make invasive populations manageable by mechanical means thereafter.

*Plant Replacement* - Plant replacement occurs in the spring, summer, and fall. In many cases, planting replacements were executed effectively. In other cases, it appeared that perennials were planted improperly and/or not provided with regular watering

during establishment. Some poorly executed plantings observed in the spring were later found to be dead or removed during the summer evaluation. Additional education at the crew level and more oversight and accountability following the completed work would help to correct this issue.

The planting of showy annuals represents a major effort each spring. This work is especially intense in high-visibility areas like Locust Walk, where the landscape is beautified in anticipation of Commencement. One opportunity to conserve resources and effort would involve replacing annual plantings with long-lived species. Increasing the use of spring-blooming bulbs, flowering shrubs, and fall-blooming perennials would provide similar benefits in spring and fall color. This effort can go further still, by enriching perennial plantings with greater diversity and resilient species mixes, as described in Appendix F.

*Trash Pickup* – This task is handled by Grounds Crews within planting beds and Hard Surfaces Crews on pavement. The two crews represent separate unions, so a distinction between "paved areas" and "grounds" is respected. These efforts are critical for maintaining the aesthetic of Penn's campus, and are a substantial part of the groundskeepers' daily efforts.

Trash pickup within planting beds is time-consuming, occupying the first two hours, or twenty to thirty percent, of every day. Significantly, these two hours typically offer the most productive hours of the day as foot traffic on campus is minimal, allowing crews the best freedom of movement. Removing trash pickup from the tasks of more skilled employees could provide them with additional time to contribute to more complex landscapes that enhance campus ecology. This might include reassigning the task of trash removal to another party, however, this would require union negotiation and leadership support. It may also be beneficial to adjust groundskeepers' hours, giving them an earlier start and more unobstructed time in the landscape, which is allowed within the terms and conditions of the unions' collective bargaining agreement.

*Leaf Cleanup* – Leaf cleanup represents a time-intensive and pollution-creating task, given the reliance of current practices on such procedures as the extensive collection of leaves, and the use of leaf blowers. While Urban Parks has begun to keep some of the leaves in place, that effort could be expanded. Alternatively, leaves could be shredded in place to provide natural mulch.

*Composting* – Currently Penn has plans to establish a leaf composting bin serving Penn Park and Shoemaker Green. This program should be expanded to collect compost from all yard waste on campus.

*Snow Removal* – Snow removal is necessary on a campus as heavily trafficked as Penn's. Currently, snow removal is very well coordinated between groundskeepers, hard surfaces crews, and housekeeping staff. These efforts are performed as needed across campus using plows, snowblowers, and shovels. In large snowfall events, snow is hauled away rather than piled in the landscape. A salt alternative, known as Ice B'Gone, is used on pathways to melt ice without harming the adjacent vegetation. Soils tests and observations of plant health have not raised any significant concerns about the effect of snow removal on the landscape. Areas initially suspected of salt damage later proved to be suffering from compaction or trampling. The minimal damage to the landscape, and efficiency of crews efforts in snow removal

*Figure 2.24 - Equipment storage in the Urban Park yard*

*Figure 2.25 - Penn Park has a new storage facility with its own tools and materials.*

illustrate the capabilities of Penn's groundskeeping staff.

Overall, there are opportunities for Penn's maintenance practices to become more fluid and holistic. The current focus on all-consuming tasks, like mulching or leaf cleanup, reduces Grounds Crew's ability to address important issues preemptively and prevent bigger, future problems. Reorganizing to allow for greater crew flexibility would greatly improve workers' ability to manage more complex landscape elements. Adaptive management, a method that would allow problems to be diagnosed and handled by the Grounds Crew, is further explored in Chapter 3 of the *ELSP*.

## STAFFING AND ADMINISTRATIVE

Penn's landscapes are managed by several separate entities under Urban Park, a division of Operations and Management within Penn's Facilities and Real Estate Services (FRES).

- Hard Surfaces and Grounds Crews manage the campus core.
- Penn Park staff, a combination of both Hard Surfaces and Grounds, manages Penn Park's meadows and the areas around its athletic fields, as well as Shoemaker Green.
- Franklin Field Grounds Crews manage Franklin Field, the Palestra, and the athletic fields and their complexes. This includes non-athletic events scheduled at these various locations as well.

Brightview, the landscape maintenance contractor, supplements this in-house landscape maintenance throughout the year. This compartmentalization creates some disparity in the types of spaces these teams maintain and even the experiences and techniques of the groundskeepers themselves. This problem was compounded by the fact that the Urban Park Manager position was vacant for

the first half of this study. Keeping this position filled is crucial to maintaining cohesion among the various departments.

In order to better inform the ***ELSP*** on staffing within the crews, informal interviews were conducted and a questionnaire was developed (See Appendix I). The responses reflect the perceptions of the groundskeepers, which were supplemented by direct observation by the ***ELSP*** consultant team.

A number of staffing challenges exist. Groundskeepers find themselves overwhelmed with a handful of event-based tasks that too often interfere with the proper timing of landscape maintenance. This is compounded by a relatively high rate of turnover and absenteeism within crews, leaving crews feeling short-staffed on a fairly regular basis.

Another commonly mentioned issue among the groundskeepers involved equipment. In a survey question that asked about access to tools and materials, more than half of the respondents felt they did not have the access to the quality tools necessary to complete their work. Landscape yards should also feature inventory information for plant material, a caged area with irrigation and shelves, break rooms, restrooms, offices, and meeting spaces.

Additional frustrations mentioned in informal interviews and in the survey pertained to the crew members' ability to advance their careers within Urban Parks. Limited opportunity to advance in both responsibility and pay appears to contribute to turnover among groundskeeping staff.

While the survey revealed frustrations surrounding maintenance tasks and organizational issues, it also suggested that, given the opportunity to advance, the overwhelming majority of groundskeepers at Penn would want to stay with the crew for the foreseeable future. The respondents were also interested in furthering their understanding of sustainability in landscape management, especially through seminars and outside consultants. Chapter 3 of the ***ELSP*** includes recommendations that would improve the working environment for groundskeepers while giving them additional opportunities for growth.

# Chapter 3
## *VISION & IMPLEMENTATION*

The recommendations in this chapter identifies ways in which Penn's management practices can better support landscape ecology. This chapter of the ***ELSP*** is directed toward stakeholders in each of four areas: design and construction, maintenance, administrative staffing, and outreach. Each of these groups have opportunities to better the management of Penn's campus landscape and expand on Penn's current successes.

### DESIGN AND CONSTRUCTION

When maintaining the campus landscape, crews are not just looking after the health of the plants, they are maintaining a vision of the campus. This vision has been in place at least since the adoption of Peter Shepheard's Landscape Development Plan, and has gradually been implemented either through the incremental modification of existing landscapes or in small leaps forward as new construction projects take place.

These projects have an opportunity to further align the aesthetic and sustainability goals of the campus and the ecological maintenance practices that follow. The process of ecological stewardship indeed begins during the planning, analysis, design,

and construction of landscapes. This section explores the current strengths in that process and identifies adjustments to facilitate a more ecologically performative campus landscape. Primary challenges include the preservation of existing natural resources, designs that manage those resources locally as well as regionally, and careful monitoring of new project installation.

Penn's campus has experienced great growth since its inception. In order to maintain a clear identity and high aesthetic standard, any new design project must conform to the vision of the Campus Master Plan and follow a design process utilizing written design guidelines and standards, posted at <www.facilities.upenn.edu/standards-policies/standards/design-guidelines>. These standards are incorporated by reference into Penn's standard form of agreement with design professionals.

Penn also relies heavily on dialogue with their design consultants when developing a project. This approach has allowed designers to put forth its own expertise and innovation under the direction of Penn's review teams.

Ecological stewardship can be supported and enhanced through this process, as exemplified by the design of the Sustainable SITES Pilot Project at Shoemaker Green. This project successfully preserved existing mature London Plane Trees (*Platanus x hispanica*), incorporated stormwater management techniques, and utilized native plantings to extend and connect habitats from Locust Walk to Penn Park. The successes and lessons-learned from Shoemaker Green inform some of the opportunities to better address an ecological landscape in the early stages of design.

To promote landscape ecology, the following topics should be

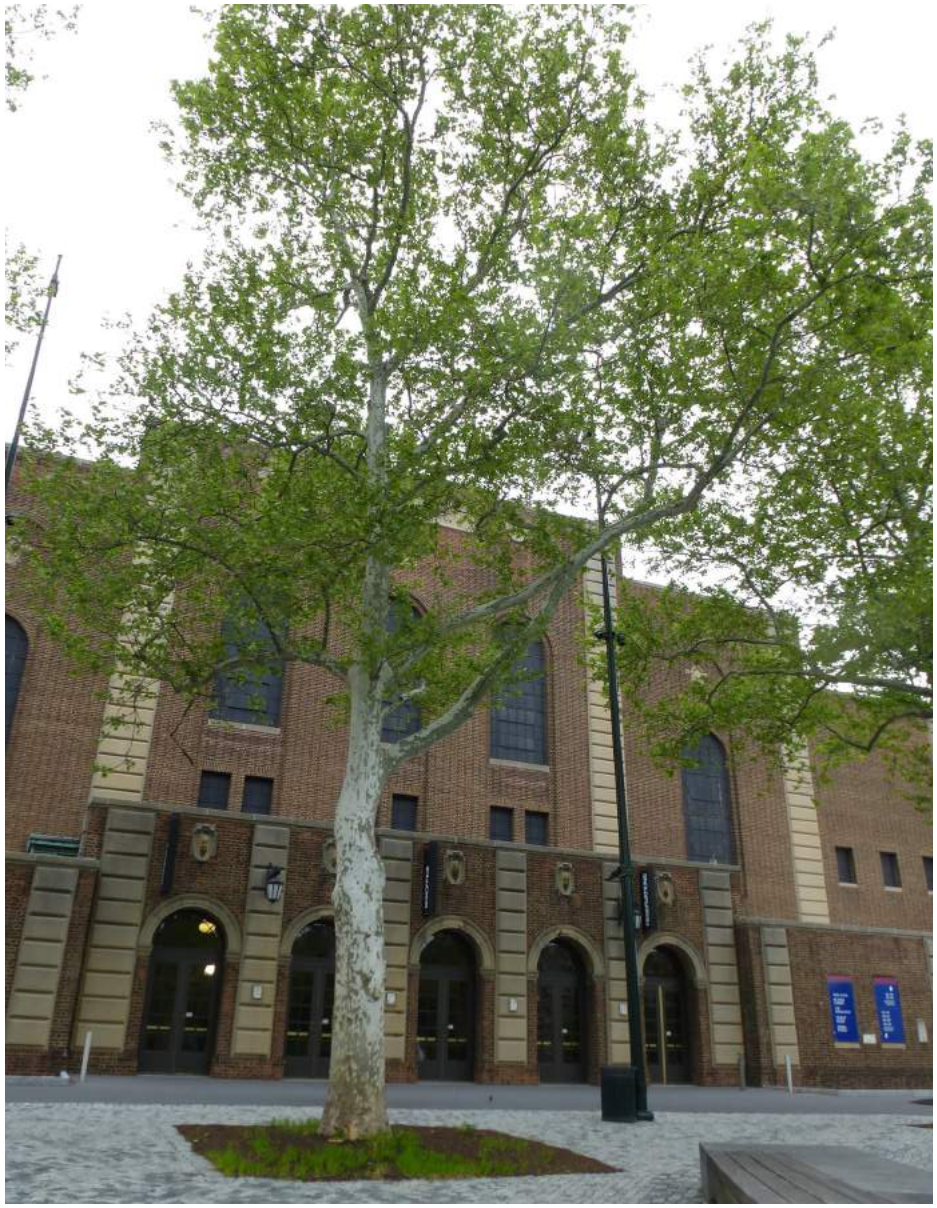


***Figure 3.1 - Mature London plane trees were successfully preserved during the construction of Shoemaker Green.***

addressed as part of the design process.

***Figure 3.2 - Protecting the existing vegetation on campus depends on both good design and mindful usage of spaces.***

***Figure 3.3 - Protection of existing trees needs to be enforced on projects of all types.***

- How does this project connect to or enhance neighboring natural resources? How could this enhancement improve the ecological function both on site and in relation to other sites in the vicinity?

- What valuable ecological features need protection? How can this protection be assured? If valuable features must be lost, can their value be replicated elsewhere?

- What level of biodiversity does the site have? Can this level be improved?

- Is there existing habitat on site? Can this habitat be expanded or improved?

- What are the soil conditions? How do these soils inform the desired plant palette?

- What are the hydrological conditions of the site? Are there opportunities for infiltration or other SMPs on the site?

- How should the landscape be maintained?

- What kind of resources will be required to manage the proposed landscape?

These questions should be revisited throughout the design process, ideally with ongoing dialogue among a team that will include the consulting design team and, from Penn, the University Landscape Architect, the Landscape Planner, and members of Urban Park, Design and Construction, and Morris Arboretum. Specific adjustments to Penn's process are detailed further in

Appendix B.

There are also opportunities to improve support of ecological landscapes within the construction process. A critical component of construction involves the protection of existing vegetation. Currently, contractors face penalties for harm done to the landscape during construction, according to the Site Guidelines for Landscape Disturbance, posted at <https://www.facilities.upenn.edu/standards/design-standards/division-32-exterior-improvements >. This *ELSP* proposes that this document be shared with any contractor performing exterior work or staging materials and equipment outside of buildings (See Appendix B). The *ELSP* suggests that the Urban Park Manager serve as point person for this communication, connecting groundskeepers with the project managers of any ongoing construction projects.

There are also opportunities to improve enforcement of tree protection requirements. The channels for reporting construction damage were unclear to a number of staff interviewed by the evaluation team. Groundskeepers are in a position to monitor damage on a regular basis, and should be empowered to do so.

Penn maintains a very high standard in construction due to a knowledgeable staff and a time-tested process. Most landscape construction is well-executed; however, some room for improvement exists that could enhance the health of Penn's ecological landscape.

As mentioned in Chapter 2, several instances of improper planting technique were observed at 40th Street Field, avoidable mistakes that resulted in declining health of many of the trees. Interviews with groundskeepers suggested that some new landscapes were

***Figure 3.4 - Recently planted beds used for staging.***

***Figure 3.5 - The same bed featured in Figure 3.4 in the following season.***

inadequately maintained through establishment by the installing contractors. It is typically the role of the general contractor and design consultant to hold installing contractors accountable for proper establishment. While this process works well most of the time, improved channels of communication connecting groundskeepers or Skilled Gardeners with project managers would give Penn an extra set of critical eyes. This would ensure that any errors were caught and corrected before Penn accepted a newly installed landscape.

Another crucial point in new construction involves the hand off between the installing contractor and Penn's groundskeepers. This is the time for groundskeepers to understand any new systems and adapt their schedule to accommodate the additional workload of a new space. The *ELSP* recommends that Penn's *Instruction to Design Professionals* require O&M manuals for landscape elements, as noted in Appendix B. Design specifications should also require a post-construction meeting between installing contractors and groundskeeping staff as part of the project's completion.

**MAINTENANCE**

As noted in Chapter 2, Penn utilizes task-based scheduling in which a single task, like mulching, is often carried out completely by the entire crew before proceeding to the next task, sometimes deferring pressing issues like watering or weeding. A more holistic approach to the landscape management would allow crews to sustain a more complex and high-performing ecological landscape.

One popular method of land management that incorporates a more flexible approach is known as adaptive management. The process of adaptive management, based on work by Carl Walters (1986) and C. S. Holling (1978), begins with an assessment to identify and understand current environmental processes and their interrelatedness. With that knowledge, actions and policies are enacted, monitored and studied in order to evaluate their effectiveness. The core concept is to remain flexible in order to incorporate adaptive responses as opportunities arise (Holling 1978).

The replacement of perished perennials provides an example of how this approach might be used on Penn's campus. Teams would determine what caused plant loss, like trampling, inadequate watering, or improper species selection. The team would then work to establish replacements and make the appropriate adjustments. In this example, if contractors trampled a plant, groundskeepers would have a plan for improving future protection. If the plant death resulted from improper species selection, such as a shade-loving plant overexposed to sun, groundskeepers would have the authority to make a recommendation for a more appropriate replacement. Monitoring and input would persist throughout this process to determine whether additional changes were needed.

This approach to maintenance would require significant education of groundskeepers. It could, however, thrive in a place like Penn, which has access to a variety of resources and research opportunities. Initial efforts would call for additional training.

Problems with adaptive management can arise when the key obstacle to success is related to something other than ecological uncertainty (Rist et al. 2013). While adaptive management offers a flexible way to address issues in the landscape, efforts should be made to distinguish between horticultural problems and organizational challenges, such as miscommunication. Such a

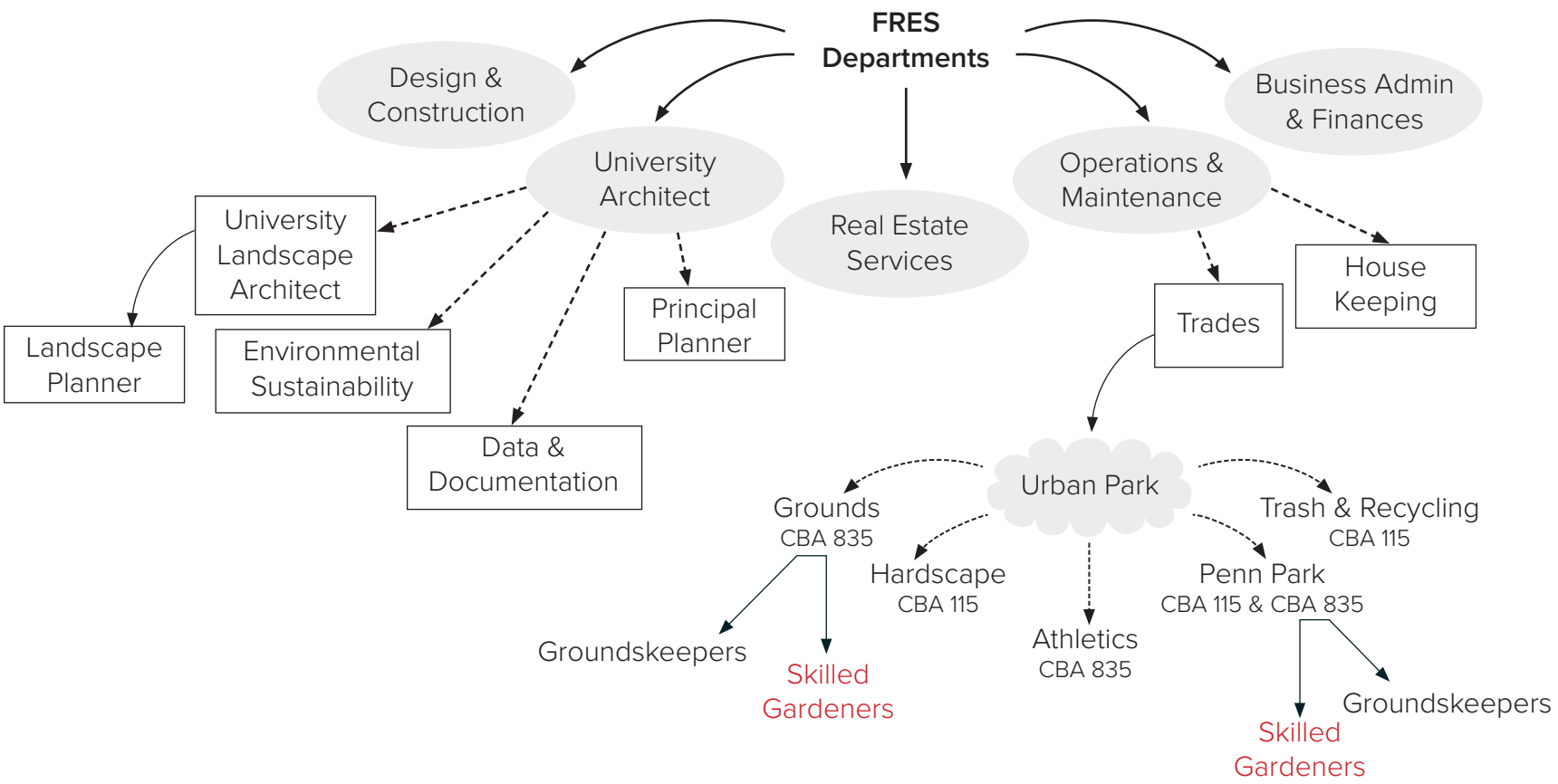



***Figure 3.6 - FRES Organizational Chart - Red indicates new position.***

risk could be minimized at Penn by giving groundskeepers more responsibility in monitoring, decision making, and scheduling of tasks.

## ADMINISTRATIVE STAFFING

Working towards a balanced, ecological landscape is a complex process, requiring a thorough horticultural knowledge of the existing landscape environment as well as what it takes to establish a more responsible and ecological one. Primarily, a motivated, well-trained team with authority, ownership and appropriate resources will create more opportunities to establish long term environmental goals as outlined in *Penn's Climate Action Plan, 2.0*. The *ELSP* recommends creating a cultural change to encourage enrichment of staff through enhanced training and opportunities. As Penn's campus landscape continues to grow and become more sophisticated, the roles and responsibilities of grounds crew must develop concurrently. Experienced Skilled Gardeners could take on this enhanced approach of landscape management.

An adaptive management approach instills ownership and stewardship principles towards landscape spaces and gardens. Properly trained Skilled Gardeners would provide knowledge, guidance and accountability towards establishing a truly responsible landscape environment. Specific qualifications, training, and education criteria would need to be established based on managing ecologically-based policy decisions. The Penn Park supervisor position created in 2011 was a step in the right direction, and much could be learned from the process that made this administrative improvement possible.
These Skilled Gardeners could also serve as point-person for other stakeholders involved in research, design, and sustainability efforts as well as helping coordinate all stakeholders in establishing and building appropriate management guidelines for use across the campus. In addition to serving Penn's needs to develop and maintain a more complex ecological landscape, this would give highly motivated staff an opportunity to enhance their expertise and exercise more independence. Additionally, less-experienced groundskeepers working with the Skilled Gardeners would have the opportunity to learn and improve their horticultural skills.

This more responsible and efficient landscape management regime, would require a shift from the current model, in which a team of groundskeepers performs assigned tasks, to this adaptive model, based on landscape type and overall needs, encouraging active, on the spot decision-making, educational opportunities and an in depth understanding of the landscape that they are stewarding.

Future studies should examine the maintenance teams of other institutions with similar programs. This will provide Penn with the context necessary to determine if its staffing and resources are adequate.

More specific recommendations regarding staffing and budget are available in Appendix H.

## COMMUNICATION AND OUTREACH

For Penn's *ELSP* efforts to succeed, they must have the support of the entire Penn community. This includes fostering an appreciation of a more ecological aesthetic as some of the landscape evolves away from a traditional management and design approach. Spreading knowledge about ecological functions on Penn's

campus can help generate interest, funding, and protection.

Maintenance needs are often difficult to communicate to donors since upkeep offers a less glamorous donor opportunity than design and implementation. Developing a maintenance budget during design and capital fundraising would help ensure that maintenance is adequately funded.

Currently the University Landscape Architect, the Landscape Planner, and the Sustainability Office, all housed within the Office of the University Architect, performs a large amount of outreach on environmental issues through newsletters, volunteering opportunities, tours, and events. There are opportunities to build on this existing messaging to advance outreach around ecological stewardship.

Examples of existing outreach that could be furthered to benefit an ecological stewardship approach include:

- Sustainability Office newsletters: Seasonal articles could explore maintenance techniques being used on campus. For example, pieces might explain the benefit of not raking leaves in the fall, the habitat created by ornamental grasses left standing through the winter, the pollination role of blooming species in the spring and summer, and the conversion of lawn into beneficial plant communities.

- Penn Walking Tours: An Ecological Landscape Stewards tour could be created to attract those interested in a guided walk featuring the ecological landscapes on campus. This would allow those interested to view the physical effects of management techniques.

- Courses: A comprehensive list of courses that feature lessons in sustainability is provided by the Office of Sustainability. This could be used to identify the necessary partners and stakeholders to contribute to an ecologically-minded adaptive management.

- Penn Plant Explorer <www.facilities.upenn.edu/services/landscape/penn-plant-explorer>: This database is used for research and teaching about the natural resources on campus. It could be expanded to include a digital tour of ecological landscapes and the environmental services that they provide.

- Tree ID Tagging Program: Penn tags over 300 individual trees with identification tags. A limited number of significant trees contain additional information, raising awareness in the University community about trees.

Similar outreach could help improve public perception and expectations about the benefits and function of sensitively managed plant communities. Such differences in expectations were cited during interviews with Penn's FRES staff. This includes past examples where complaints have been fielded about meadow grasses left standing through winter, causing them to be mowed at a time when they provided valuable habitat; or when leaves were intentionally left in planting beds to enrich soils and reduce labor, but later ordered to be removed due to aesthetic concerns. Signage communicating the benefits of native plant communities and ecological management initiatives could help align people's aesthetic expectations and engage people in the richness of the ecological landscape around them.

## CONCLUSION

Penn is already a leader in environmental sustainability and has made tremendous gains in ecological landscape design and maintenance in the past decade. Yet opportunities exist to push this effort further and create a campus landscape that is fully integrated within the regional ecology.

The ecological landscape is one that is rich in habitat, resilient, and remains healthy and beautiful with minimal inputs. Penn's efforts toward this goal should be multifaceted. Penn's Grounds Crews and their support network need to develop greater ownership of the landscape and become a more horticulturally proficient workforce. In addition, groundskeepers' stewardship efforts need to be more fully integrated into design, construction and fundraising activities.

Finally, high performing landscapes on campus should be highlighted and put forth as a model, while weaker landscapes should be nurtured and enriched.

The following appendices include very specific steps to better achieve these goals. Recommended implementation targets, adjustments to standard documents, recommendations on planting and maintenance are all included.

Penn enjoys a well-deserved reputation as one of the most influential contributors of knowledge in the country. The legacy of many notable landscape architects and planners from Penn's faculty guided and set the standard for Penn's unique campus character. *The Landscape Design Guidelines* (LAMP) from 1977 established both design and environmental principles that


***Figure 3.7 - Outreach could be as simple as incorporating editable signs into the landscape.***

established Penn's leadership in environmental stewardship and practices. Both the *Climate Action Plan* and the *Climate Action Plan 2.0* have more recently provided targets to keep Penn on the forefront of that effort. The recent designation by ArbNet Arboretum Accreditation Program of the campus as an arboretum clearly acknowledges and celebrates this commitment to environmental principles, as does the eight consecutive years of Tree Campus USA designation from the Arbor Day Foundation, the SITES initiative award, and many others.

Building on these ongoing and emerging practices, the University, through this ***Ecological Landscape Stewardship Plan***, seeks to further enhance our landscape management principles towards a more ecologically responsible campus environment. As University President Amy Gutmann has said in another context- taking our principles "from Excellence to Eminence."

# References

**Articles & Books**:

Bassett, Corinne G. “The Environmental Benefits of Trees on an Urban University Campus” (2015). Master of Environmental Studies Capstone Projects. Paper 66.

Bolund, Per and Sven Hunhammar. “Ecosystem Services in Urban Areas.” *Ecological Economics*, vol. 29, 1999, pp. 293-301.

Ecological Society of America. “Ecosystem Services: Benefits supplied to Human Societies by Natural Ecosystems.” Issues in Ecology. Number 2, Spring 1997. http://www.esa.org/esa/wp-content/uploads/2013/03/issue2.pdf, http://www.esa.org/ecoservices/comm/body.comm.fact.ecos.html and UNESCO, http://www.unesco.org/mab/doc/iyb/faq.pdf.

Grime, J.P. “The C-S-R model of primary plant strategies — origins, implications and tests.” *Plant Evolutionary Biology.* Springer, 1988.

Hansen, Richard and Stahl, Friedric. *Perennials and Their Garden Habitats*. Portland: Timber Press, 1993.

Holling, C.S. *Adaptive Environmental Assessment and Management*. Chichester: John Wiley and Sons, 1978.

Rist, Lucy, et al. “A New Paradigm for Adaptive Management.” *Ecology and Society*, vol. 18, no. 4, art. 63, 2013.

Walters, Carl. *Adaptive Management of Renewable Resources*. New York: Macmillan Publishing Company, 1986.

**Websites**:

United State Department of Agriculture (USDA NRCS. <http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>

U.S. Composting Council. Seal of Testing Assurance (STA). <http://compostingcouncil.org/seal-of-testing-assurance/>

**University of Pennsylvania Studies and Guidelines**

*A Stormwater Master Plan for the University of Pennsylvania*. <https://www.facilities.upenn.edu/sites/default/files/Stormwater%20Master%20Plan%20for%20the%20%20University%20of%20Pennsylvania_March%202013_web.pdf>

*Climate Action Plan*. <https://www.sustainability.upenn.edu/sites/default/files/pdf/PENN-2009-Climate_Action_Plan.pdf>

*Climate Action Plan 2.0*. <https://www.sustainability.upenn.edu/sites/default/files/pdf/Penn%20Climate%20Action%20Plan%202.pdf>

*Design Guidelines*. <https://www.facilities.upenn.edu/standards-policies/standards/design-guidelines>

*Landscape Development Plan*. < https://www.facilities.upenn.edu/sites/default/files/Landscape%20Development%20Plan%20February%201977.pdf>

# Appendix A
## *IMPLEMENTATION*

This section outlines a list of specific actions that will elevate Penn's stewardship of the landscape to meet the goals of the ***ELSP***. These tasks are organized into categories of Design, Construction, Staffing, and various landscape maintenance types. Within each category, the responsible parties at Penn and the target date of completion are identified. Target dates are identified broadly by end of calendar year.

Key to the implementation of these goals is clearly defining how these goals will be accomplished and who will be accountable. Penn will determine whether existing staff or outside consultants should fill this role. A similar process was used to achieve goals put forth by other studies, including the ***Solid Waste Management Plan*** (2013).

## DESIGN

The following items should be coordinated efforts between the Landscape Planner, University Landscape Architect, Design & Construction project managers, the Urban Park Manager, and Urban Park supervisors.

*2018:*

• Require that all new design projects include an analysis of the ecological value of the site. This would include pre-construction and post-construction evaluations of the following: structural biodiversity, species biodiversity, percentage of native species within vegetated beds, areas of infiltration, and number and appraised value of mature trees.

• Require meetings between design teams, Urban Park Manager and Urban Park supervisors throughout the design process. At a minimum, these should occur at the end of concept design, the end of schematic design and design development, and at relevant "descope" meetings.

## CONSTRUCTION

The following items should be coordinated efforts between the Landscape Planner, University Landscape Architect, Design & Construction project managers, the Urban Park Manager, and Urban Park supervisors.

*2018:*

• Refine the “Tree Protection Specifications” as recommended in Appendix B

• Implement a policy to distribute the “Site Guidelines for Landscape Disturbance” to all contractors involved in projects that involve exterior staging or exterior construction.

• Make the Urban Park Manager the central contact for any observed landscape disturbances. Provide the Urban Park Manager with a list of current and upcoming construction projects, including the contact information for each project’s construction supervisor and project managers.

• Require as part of the closeout in landscape specifications that all projects include a Post Construction meeting involving Urban Park supervisors and groundskeepers.

*2020:*

• Involve “Skilled Gardeners” in a brief weekly site visit to monitor landscape construction projects being implemented by third party contractors. This review period would occur from the week prior to spreading topsoil until the end of the maintenance period.

## STAFFING AND ADMINISTRATION

The following items should be coordinated efforts between groundskeepers and supervisors.

*2018:*

• Provide intensive training for all current grounds staff focusing on ecological stewardship and adaptive management practices. Include such topics as weed management for specific species, identification of diseases, and proper planting practices. Highlight proper mulching techniques for trees.

• Implement a continuing education policy providing a defined number of hours for groundskeeping staff.

• Develop a job description for the “Skilled Gardeners.” Establish

specific qualifications and education criteria. Include greater responsibility and higher pay. Economic guidelines to be established by senior leadership prior to negotiations.

• Pursue feasibility study for setting up compost facility at Pennovation Site.

*2020:*

• Analyze staffing, performance, and organizational structure of grounds crews with the assistance of an organizational consultant if and as necessary. Compare performance with similar institutions in order to clarify opportunities for better performance.

• Determine quantity of needed "Skilled Gardeners" and assign position.

## LANDSCAPE EQUIPMENT

The following items should be coordinated efforts between groundskeepers and supervisors.

*2018:*

• Take stock of current landscaping equipment. Repair, replace or acquire additional equipment required to improve efficiency.

• Consider the following additional tools:

- Portable leaf shredders for shredding leaves in-situ
- Electric string trimmers to reduce emissions
- Flame-weeders and deep-root upright weeders to facilitate efficient, herbicide-free weed control.
- Tablet devices to allow crews to easily document and share findings in the field.
- Reusable weed and leaf collection bags
- Tools for sharpening/maintenance of garden tools.

• Set an annual budget for landscape equipment purchases.

*2020:*

• Give Skilled Gardeners the authority to purchase or repair equipment under an agreed upon dollar amount.

• Set up an enlarged composting facility serving the entire campus at the Pennovation site, pending results of feasibility study.

## HERBACEOUS/SHRUB BED MANAGEMENT

The following items should be coordinated efforts between the campus landscape architect, the campus planner, supervisors, and groundskeepers.

*2018:*

• Identify and map the location of dense groundcover plantings across campus that would benefit from the omission of mulch. Examples include beds dominated by species of Carex, Aster, Helleborus and similar colonizing species.

• Eliminate the use of annuals within low profile areas, plant perennials and bulbs instead.

• Identify and map locations where a dense native groundcover (“living mulch”) could be interplanted to eliminate the need for mulch between taller, more open species (for example, underplantings of Carex species amongst Ilex glabra).

• Identify areas dominated by low, herbaceous plantings that could be diversified by shrub plantings. Aim for a 33% shrub cover in herbaceous beds.

• Determine current diversity statistics for perennials, groundcovers, and shrubs.

• Identify areas of extreme weed infestation that cannot be controlled by mechanical means. Utilize a one time herbicide application to control major infestations, so that invasive populations can be realistically controlled by mechanical means.

*2019:*

• Eliminate the use of mulch among dense groundcover plantings.

• Prioritize weeding over mulching efforts.

• Map the use of annuals across campus. Identify high profile areas where spring blooms from bulbs and perennials are strong enough to justify replacing annuals with perennials the following year. In areas where spring bloom is weak, plan for a fall planting of bulbs and spring blooming perennials.

• Interplant native groundcover plantings amongst taller perennials and shrubs in order to create “living mulch”.

• Plant a shrub layer in areas identified in summer 2017 evaluations. Utilize urban-tolerant, primarily native shrubs that mature at a height lower than 48”. In high profile locations, use plant combinations that emphasize spring and fall interest such as species of *Hydrangea, Fothergilla, and Itea*.

• Plant supplemental bulbs and spring blooming perennials where needed based on summer evaluations.

*2020*

• Give Skilled Gardeners the authority to evaluate planting beds and advise supervisors on the species and quantities of replacement or supplemental plantings.

• Perform a study of the entire campus reporting on the current health of various plant communities, defining high profile “display” areas vs low profile areas, and proposing planting strategies for enriching plant communities and meeting aesthetic expectations.

•Continue to minimize the use of annuals across campus

*2050*

• Meet the Climate Action Plan species diversity goal of no more than 10% of any species, 20% of any genus, or 30% of any family for perennials and shrubs across the entire Penn Campus. This allows time for a more diverse species makeup to become incorporated as trees and shrubs reach their natural end of life.

**TREES**

The following items should be coordinated efforts between the campus landscape architect, campus planner, supervisors, groundskeepers, and third party contractors.

*2018*

• Identify and remedy trees with stem girdling roots across campus. Immediately mulch or plant groundcovers within tree-circles after the root collar excavation is performed.

• Identify “Low Profile” vs. “High Profile” locations across campus for handling leaves in the coming fall. Areas like the bosques of trees at 40th Street Field would be considered “Low Profile”, as

they are not the immediate frontage of a building and not among the more iconic spaces in the landscape. An area like Locust Walk would be considered “High Profile” as it is both an iconic space and the beds are largely the foreground to building frontages.

• Let leaves lay in areas considered “Low Profile”, and place temporary signage in these locations explaining the ecological benefits of letting leaves lay instead of removing them.

*2019*

• Shred leaves in place in “High Profile” locations and let leaves lay (unshredded) in “Low Profile” locations. Again utilize temporary signage to explain the benefits in both conditions.

*2020*

• Perform a study for long term tree layer/tree replacement.

*2050*

• Meet the Climate Action Plan species diversity goal of no more than 10% of any species, 20% of any genus, or 30% of any family for trees.

**LAWN**

The following items should be coordinated efforts between the campus landscape architect, campus planner, supervisors, groundskeepers, and third party contractors.

*2018*

• Monitor and map user activity in lawn areas across campus. In order to identify and prioritize areas where lawn might be reduced and biodiversity could be enriched, divide lawns into the following categories:

- Type 1: “High Profile” locations where the lawn is utilized for major events and experiences daily activity (Such as the lawn at Shoemaker Green).
- Type 2: “Low Profile” locations that experience daily activity but do not serve as a setting for major events (Such as the lawn at 40th Street Field).
- Type 3: “Unused, Aesthetic Lawns” Locations where lawn is rarely used, but contributes to the landscape aesthetic (Such as the lawn at Kane Park).
- Type 4: “Unnecessary Lawns” Locations where the lawn is rarely utilized, nor is it aesthetically important (such as the unused sections of lawn under the tree canopy at 40th Street Field).

*2020*

• Initiate trials of lawn types and management under the guidance of a consultant with expertise in organic turfgrass management. These trials should commence in 2020 and may be ongoing over 5 years or more.

- Identify preferred lawn seed mixes by performing on-campus trials in various conditions of sun exposure and foot-traffic. Use these trials to inform the campus standard mixes for lawn Types 1, 2, and 3 as described below.
- Perform studies of corn gluten as a pre-emergent, using various application rates and timing scenarios. Use these studies to inform campus standard practices.

### *2020-2050*

• Gradually Transition the four lawn types as follows. Note that seed mixes may be adjusted based on the findings of the 2020 lawn trials.

- Type 1 (High Profile, Well Used Lawns): Replace soils with an imported mix like the soil at Shoemaker Green (See Specification C) and seed using a resilient Hard Fescue dominant mix. Ensure irrigation and underdrainage are incorporated into these lawn areas. Where possible, incorporate stormwater collection and infiltration with these lawn revitalizations.
- Type 2 (Low Profile, Well Used Lawns): Amend soils with compost and utilize a resilient Hard Fescue dominant mix. Where soils are extremely compacted and poorly draining, rip or fracture subsoils to a depth of 24” and amend with compost.
- Type 3 (Unused, Aesthetic Lawns): Utilize a low grass suitable for the level of sun vs. shade, such as Boutelua, an evergreen Carex species, or a “No Mow” mix.
- Type 4: (Unused, Aesthetically Unimportant Lawns): Replace lawns with perennial/shrub plantings.

# Appendix B

## *REVISIONS TO STANDARDS & SPECIFICATIONS*

The ***ELSP*** recommends a number of adjustments to Penn's existing standards and specifications to facilitate a more ecological campus stewardship approach. The recommended revisions to those standards are outlined in detail within this appendix section.

The following documents are addressed:

• *Instructions to Design Professionals*, September 2006 < https://www.facilities.upenn.edu/standards-policies/standards/design-guidelines>.

• *Green Guidelines to Renovation*, October 2015 < https://www.facilities.upenn.edu/standards-policies/standards/design-guidelines>.

• Specification 32 01 90.33.0 Tree Protection, March 2011 < https://www.facilities.upenn.edu/standards/design-standards/division-32-exterior-improvements>.

## INSTRUCTIONS TO DESIGN PROFESSIONALS

**Statement of Purpose and Objectives**

The *Instructions to Design Professionals* has been created by the University of Pennsylvania Division of Facilities and Real Estate Services to provide a guide for design consultants to the University's procedures for executing capital projects. It is intended to ensure that consulting architects and engineers contribute to the goals of the University, serve the needs of the users, and make efficient use of University resources. Together with the Agreement between the University and design professionals, this document establishes the contractual obligations of each party.

The *Instructions to Design Professionals* references and links the reader to other documents, which help define procedures and the scope of services to be provided by consultants. This document addresses:

- Forms of Agreement
- The Project Team, Roles, and Responsibilities
- Project Communication
- Project Phases
- Building Commissioning
- Sustainability Policy
- Additional Design Issues
- Utilities and Building Systems
- Documentation Format and Graphic Standards

**Forms of Agreement**

The University of Pennsylvania engages the services of architects, engineers and other professionals for the design of its facilities through the use of the *Standard Form of Agreement for Architectural and Engineering Services*, the *Short Form of the Agreement*, or the *Services Form of Agreement* (all referenced in this document as the Agreement). The design professional is required to review and be governed by the contents of these Agreements, which are the primary documents establishing the relationship between the consultants and the University. In cases of conflicting information with other documents (including the design professional's proposal for services), or any omissions, the Agreement will govern.

**The Project Team, Roles, and Responsibilities**

***Architect / Engineer (A/E):*** The A/E includes all prime design professionals with whom the University enters into a professional Agreement for design services, and their consultants. The A/E acts in the University's best interest as the design lead for the project team. The A/E may be a multidisciplinary firm providing comprehensive services, or a single-discipline consultant contracting directly with the University. Responsibilities are defined in this document, as well as other documents such as *The Penn Design Guidelines and Review of Campus Projects* (http://www.facilities.upenn.edu/uop/BldgDesignGuidelines.pdf) and the *Technical and MEP Guidelines* (http://www.facilities.upenn.edu/getDone/designguides.php3). The A/E is to be aware of the content of these documents and review questions regarding project application with the Project Manager.

The lead design professional is to provide for supporting consulting services as appropriate for the project (sub-consultants may include civil, structural, mechanical, life-safety, communications and information technology, electrical engineering services, and/or landscape architecture services.) The consultant's drawings and specifications are to be coordinated and presented for review by the University at the conclusion as appropriate. Each of the consultants shall be registered to practice in the State of Pennsylvania. The University reserves the right to reject any consultants proposed by the lead A/E.

***Project Manager (PM)*:** The PM is the University's representative from the Division of Facilities and Real Estate Services assigned to each project, is the primary agent of and contact for all University parties, and represents the interests of the University throughout all phases of the work. The PM is responsible for

management of the project and has primary responsibility for the project budget and schedule. The PM also works closely with the Office of the University Architect, the Office of the University Engineer, and all other University stakeholders to coordinate their varied areas of focus and coordinate their project review comments and feedback. The PM signs off on the completion of each project, approves payment for consultant services, and with the support of the A/E and Contractor, tracks all project expenditures and changes to scope and / or schedule.

***Contractor:*** The University may elect to engage a Construction Manager or General Contractor (either are referred to in this document as the Contractor), who is responsible for the execution of the work in accordance with the contract documents prepared by the A/E, adherence to the project construction schedule and budget, and management of sub-contractors. If the University selects a Contractor prior to completion of the contract documents, the A/E is to cooperate fully with the Contractor, and provide periodic updates of drawings, specifications, and cost estimates to the Contractor as required. The contractor may be asked to perform construction feasibility reviews, investigate cost savings and value engineering opportunities, and may be involved in pre-construction activities (such as estimating and pre-construction services).

***Project Committee***: The Project Committee is comprised of representatives from the sponsoring School or Center, user groups, the Office of the University Architect, the provost's office, and/or other University stakeholders, and is responsible for reviewing and approving A/E work. The PM chairs the Project Committee, and is the point-of-contact for communication with the A/E.

***Design Review Committee****:* The Design Review Committee (DRC) advises the Trustees of the University on approval of all projects that have a significant impact on campus. The committee is comprised of representatives from Facilities and Real Estate Services (FRES), faculty, Trustee representatives, and design professionals drawn from the extended University community. The committee meets monthly and as needed.

***Cultural Resources Sub-committee***: The Cultural Resources Sub-committee (CRS) of the DRC reviews all projects of historical importance on the campus, or within designated historical districts. The CRS is comprised of representatives from the University and the Philadelphia Historical Commission. The CRS meets monthly and as needed.

**Project Communication**

***Meetings:*** The PM will schedule meetings as determined by the Agreement. The A/E coordinates agenda items for all meetings with the PM at least 24 hours prior to the meeting, and is responsible for writing and distributing meeting notes as described in the Agreement.

***Progress meetings*** are to review project progress and discuss project issues with the Project Committee, user group representatives, University staff, and/or others as required.

***Presentation meetings*** are scheduled by the PM as required to review the design with the Project Committee and / or the DRC or CRS, and are typically held at the conclusion of each phase of design and documentation. The A/E is to prepare digital images suitable for projection and archiving, in addition to other forms of presentation required for a full review of the design. The Office of the University Architect is responsible for preparing and distributing notes from the DRC and CRS meetings.

***Correspondence:*** Project correspondence with the University is to be addressed as follows:

Attn: Project Manager
Division of Facilities and Real Estate Services
University of Pennsylvania
3101 Walnut Street
Philadelphia, PA 19104 –6289

***Project Directory:*** The A/E is to assemble and maintain the project directory throughout the project. This directory is to include a listing of all primary and emergency contacts, decision-makers, discipline leads for the A/E, Contractor, all consultants, and key University personnel. The project directory is to also include the government, utility agency, and insurance carrier information as appropriate.

***Distribution Matrix:*** A distribution matrix is to be generated for all forms of communication including meeting minutes, monthly reports, cost estimates, schedules, construction documents, and other contract deliverables. The PM will approve the distribution of all project information.

***Project Procedures Manual:*** For larger projects the A/E may be required to assemble a Project Procedures



Include the following category within the "Project Committee":

***Stewards: University Landscape Architect, representatives from Morris Arboretum and Urban Park should be among the stakeholders included in the project committee.***

Manual for use by the project team. The Project Procedures Manual is to contain information relative to project procedures, communication, and agreed upon processes. This document is to be used as a guide by the project team to coordinate their individual efforts.

The specific contents are to be developed with the PM and Contractor and may include information such as organizational charts, project description, project schedule, shop drawing procedures, project initiation and close out procedures, and other documentation required by the University. If a Project Procedures Manual is required for the project, the Project Directory and Distribution Matrix will be included in the manual.

The Project Procedures Manual may also include examples of certain documents to be used during the project, such as transmittal forms, RFIs, field visit reports, drawing title block, and change order request and/or approval forms.

***Invoicing:*** During the course of the project the A/E is to submit invoices for payment to the PM not more often than monthly, as described in the Agreement. All applications for payment of additional services or reimbursable expenses are to be identified by the Agreement number and / or accompanied by an authorization letter(s) issued by the PM.

***Publicity Approval:*** Consultants who work on University projects are required to receive written approval from the Office of the University Architect prior to seeking publicity regarding the project, submitting the project to architectural competitions, or engaging in similar activities. Such approval will not be unreasonably withheld if the A/E's effort does not conflict with University plans or policy. All photographs, models, sketches, and renderings prepared in the course of the design or prepared as additional services are the property of the University unless otherwise defined in the Agreement. Permission from the Office of the University Architect must be obtained for their use or reproduction.

**Project Phases**

Professional design and / or consulting services are accomplished by successive phases, in accordance with the Agreement. Typical phases of a capital project are: Pre-Design / Programming Phase; Schematic Design Phase; Design Development Phase; Construction Documents Phase; and Construction Administration Phase (including bid, negotiation, & award). Each phase of work is based on the previous, approved phase. The A/E is not to proceed to the next phase until instructed to do so by the PM.

Upon completion of each phase of a capital project, the PM will arrange a presentation meeting to the Project Committee, and, if the project has significant impact to the campus, to the Design Review Committee. The A/E is to submit the required copies of the appropriate documents in advance of this meeting, as directed by the PM. If the Design Review Committee requests modifications to the design, the PM may schedule another meeting for the A/E to present design revisions before proceeding to the next phase.

Also at the end of each phase, progress documents are to be distributed through the PM for review and approval by University stakeholders, including but not limited to the Project Committee, the Office of the University Architect, the Office of the University Engineer, the Division of Public Safety, Office of Fire and Emergency Services, and Facilities Management (Operations). The A/E is to provide written responses to these comments to the PM, and receive acknowledgement of the responses and authorization before proceeding. A meeting with the PM and other University stakeholders may be required to resolve any questions or concerns.

Unless otherwise directed by the PM, an estimate of probable construction cost is to be included as part of the deliverables of all design phases of capital projects. Estimates of probable construction costs are to include contingencies and contractor overhead and profit, and are to be organized by the Construction Specifications Institute (CSI) format with detailed breakdowns by specification section. If directed by the PM or as part of the established project deliverables, cost estimates are also to be broken out by major building components, systems, or anticipated phased construction.

***Project schedule information***

As a basis for developing the project fee and schedule, the A/E is to note the following typical schedule requirements. Note also that many of these issues and reviews are pursued concurrently, so that the critical path issues of the design, documentation, and project delivery schedule are not adversely impacted.

- The contract between the University and the A/E usually requires four weeks to be signed and executed. Design services will commence upon issuance of a notice to proceed, often in advance of issuance of an executed contract;



Append the following sentence within “Project Phases”:

*“Also at the end of each phase… …including but not limited to… …University Landscape Architect, Morris Arboretum, and Urban Park.”*

- The project committee reviews at the close each design phase will require approximately two weeks each.
- The City of Philadelphia permit approval process may require reviews by the Department License and Inspection and the Zoning Unit, and it may take as long as twelve weeks to gain final approval for new construction. The A/E is to work with the PM and the Office of the University Architect to address the City review requirements early in the design process, and to schedule submissions so as not to delay the project. For complex projects, a preliminary meeting is sometimes scheduled with the City representatives through the Office of the University Architect.
- The Contractor's bid/award process (pre-bid meeting, response to contractors questions, bid opening, bid review, de-scope meetings) could take up to eight weeks for a large project.
- The contract between the University and the Contractor typically requires four weeks to be signed and executed. Construction does not begin until a contract is executed. This period is often used by the Contractor to secure required trade permitting and begin gaining University approvals for required submittals.

***Feasibility Studies:*** At times, work will be commissioned that does not include the preparation of construction documents or construction administration, such as a feasibility study. The purpose of a feasibility study is to define a potential capital project's scope, program, and cost in order to gain internal University capital project approvals. An accurate cost estimate, based on the full scope of work of a potential capital project must be identified in the study. Existing site or building conditions, campus infrastructure, and building engineering systems must be verified by the A/E as part of this study, without relying on the accuracy of prior documentation.

***Pre-Design / Programming / Program Confirmation Phase***
The A/E is to develop the project program for the proposed project, or confirm the project program if one is provided by the University. As part of this phase, the A/E is to confirm the original proposal, A/E team composition, schedule, and scope of work. Any changes from the initial proposal must be approved by the PM.

For projects that will significantly impact the appearance of the campus, the PM will schedule a review by the Design Review Committee to establish the design framework in accordance with the *Penn Design Guidelines and Review of Campus Projects* (http://www.facilities.upenn.edu/uop/BldgDesignGuidelines.pdf).

**A/E deliverables**
- The A/E is to work with the PM to identify any pertinent applicable existing site or building documentation, and to identify any required site surveys, geotechnical analysis, or test borings that will be required
- The project program establishes the goals of the project by listing the spaces, functions, and/or proposed renovations needed by the school or center. The Project Program is developed or confirmed with input from the Project Committee, and serves as the basis for the Schematic Design Phase.
- An estimate of probable cost, based on preliminary studies carried out or revised during this phase.

***Schematic Design Phase***
During Schematic Design, the A/E is to create initial design documents to define and convey the scope of work. In consultation with the Project Committee, the A/E is responsible for the completion of the project program for approval by the University. Program priorities and assumptions are to be re-evaluated to determine if spaces and functions can be shared or co-located, with the goal of reducing the scope of the project, and increasing space and resource efficiency. The A/E is to verify all existing conditions and to avoid assumptions regarding existing building systems and/or site utilities.

Integrated design exercises are to be conducted where appropriate to bring together the A/E's consultants and key University participants in the design / build / operate process, to identify potential conflicts and coordinate design goals. The emphasis of these exercises is to focus on improving overall building or facility performance.

Schematic design documents are to show the architectural and/or engineering concepts, site relationships, landscaping approach, massing, site and / or building circulation patterns, environmental and energy-use strategies, and building systems as required to meet the functional, economic, environmental, and aesthetic goals of the project. The A/E is to work with the PM and the Office of the University Engineer to review utility requirements, building system concepts, campus utility availability, and energy efficiency strategies.



Add one item to the list under "Pre-Design Phase A/E deliverables":

*An existing conditions drawing indicating all individual trees and areas of vegetation, and a schedule describing the size, health, and ecological value of each tree on the plan. This plan should cover all areas within 100' of the anticipated construction zone. Representatives from Urban Park and Morris Arboretum are available to assist in the analysis of existing trees.*

The A/E is to review the results of any test borings, site survey, and geotechnical analysis with the PM and other University representatives, as required. The A/E is to provide the scope of work for any geotech or survey work required.

**A/E deliverables**

- Project program (if not identified in a pre-design phase);
- An area analysis (a comparison of program needs to proposed design);
- Overall site or building location plan, showing the relationship between existing and renovated space or existing and proposed, and landscape design (if required). Any special requirements for related landscape improvements and services or utilities are to be included;
- Documentation of existing utilities, proposed connections, and phasing plans for all utility work, especially where existing utilities are to be affected by new construction. The documents are to include a description of any proposed interruptions of utilities service and / or proposed shutdowns caused by new construction. New building drawings are to include designation of site utilities, feeds, and any required systems infrastructure. Record documents of existing campus infrastructure can be attained through the PM;
- Schematic floor plans, preliminary sections and elevations, and building massing studies where appropriate;
- Preliminary drawings and narratives to indicate various building systems (structural, mechanical, electrical, plumbing, etc.), their general performance and life-cycle efficiency characteristics, including analyses of alternative systems, wherever applicable;
- Schematic outline specifications, including initial selection of interior and exterior finishes, fixtures, devices, equipment, and appliances;
- A project schedule that identifies the start and finish dates and durations of each project phase (including the construction), milestones, and meeting schedules, as approved by the PM. Phasing requirements are to be included as necessary for the execution of the work;
- An estimate of probable construction cost:
- Written responses to comments from University stakeholders.

***Design Development Phase***

During design development, the A/E is to develop a level of design detail necessary to define a clear, coordinated description of all aspects of the project. The A/E expands the level of design integration, design concepts are coordinated among all team members, and cost metrics (capital, operations, and life-cycle) are developed and evaluated against performance considerations. The A/E is to review the project schedule to ensure that adequate time is reserved for implementing the decisions and directives of the Project Committee.

Projects that were reviewed by the Design Review Committee and / or the Cultural Resources Sub-committee during schematic design may be reviewed again during this phase, as directed by the PM. The A/E is to arrange for a presentation to fully describe critical interior and exterior finish materials for review and approval.

**A/E deliverables**

- Updated building program, highlighting changes from the schematic design;
- Site plans, with dimensioned locations of each building element, existing and finished contours, ground floor elevations, location and extent of roads, walks, parking areas, utilities (existing, new, and relocated), site construction, limits of work, and all the required information for the City of Philadelphia Institutional Development District zoning application. (The A/E is to provide necessary documents and to assist the Office of the University Architect in submitting all zoning and building applications);
- Site plans and building plans are to indicate locations of utility connections, new feeds and distribution pathways if required, and all related systems infrastructure;
- Landscape plans, showing the type and location of all landscape elements and all site construction (planting, retaining walls, steps, lighting, walks, roads, and other details as required);
- Floor plans, including updated architectural, equipment and finish plans;
- Reflected ceiling plans, showing materials selected and locations of major ceiling elements;
- Updated sections and elevations, including detailed wall sections showing construction methods and materials. Include foundations, floor and roof heights;
- Additional presentation materials as required to explain the interior and exterior design;
- Structural drawings, indicating structural system and major elements;
- Mechanical, electrical, and plumbing drawings, including layouts and distribution diagrams and apparatus and fixture cut sheets. Major equipment is to be accurately indicated on plans and elevations



Add one item to the list under “Schematic A/E deliverables”:

***Site demolition plan indicating trees and other significant vegetation***

in terms of size and location. Coordinate drawings to eliminate conflicts between trades and/or disciplines;
- Revised outline specifications, to including materials and color selections;
- Updated project schedule, with start and finish dates of each project phase (including construction administration), deadlines, and meeting schedules, as approved by the PM;
- Updated estimate of probable construction cost;
- Operating costs for the first five years of the new building or space use are to be submitted to the PM as indicated in the Agreement and as directed. Where available, the University will assist in this cost assessment by providing operations and maintenance historical data as pertinent. Energy costs are to be included in this report but calculated separately. For renovation projects, the A/E is to identify those components of the project that will affect the facility's operating and maintenance costs and provide an estimate of the net change, paying special attention to factors such as change in use and new equipment that will alter existing energy consumption. The A/E is to present proposed energy and resource-saving strategies as part of this exercise;
- Written responses to comments from University stakeholders.

***Construction Documentation Phase***
The A/E is to complete fully coordinated construction documents, suitable for competitive bidding of the work. Specifications are to be provided in the standard format of the Construction Specifications Institute, and are also to include the General and Special Conditions (to be developed in conjunction with the PM). If the construction methodology requires multiple bid packages, the A/E is to prepare such documents as required.

As directed by the PM, the A/E is to complete documents for submittal for zoning and permit applications during the Construction Documentation Phase. The approved permit sets are to be kept at and readily available at the project site during construction. At the conclusion of construction activities, these documents are to be delivered to the PM for archival purposes in the Data and Documentation Office of the Office of the University Architect.

At approximately 90% completion of this phase, the PM will arrange a review meeting with the A/E, to be attended by all project stakeholders. The A/E is to incorporate all appropriate comments into the bid documents prior to bidding. Bid documents are to undergo a thorough in-house quality control and coordination review by the A/E prior to bidding.

The Construction Documentation Phase is complete at the issuance of all construction drawings and specifications, which include, but are not limited to, construction drawings, specifications, and instructions to bidders.

**A/E deliverables**
- Progress documents, as required by the Agreement;
- 90% Review Documents;
- Mock ups, as required by the Agreement;
- Final material samples, finish selections, and mock-ups as required;
- An updated estimate of probable construction cost;
- Written responses to comments from project stakeholders;
- Completed construction documents for bidding.

***Construction Administration Phase (including Bid, Negotiation, & Award)***
During the bid, negotiation, and award process, the A/E is to participate in the pre-bid conference to describe the work, answer any questions regarding the documents, review bids for completeness, de-scope the bids, analyze pricing versus estimates, and recommend award. As designated by the PM, the A/E is to provide clarifications or addenda to bidders (which are issued by the PM).

The A/E is to assist the University in the administration of the construction contract, providing clarification and interpretation of Contract Documents. The A/E is to make periodic visits to the site to observe the progress and quality of the work and conformance with the contract documents, attend construction progress meetings, and prepare and issue record notes of these meetings. The A/E shall exercise due diligence to safeguard the University against construction defects, deficiencies, noncompliance with drawings and specifications, and/or unsatisfactory workmanship. If, in the opinion of the A/E, the work is not being carried out in a sound, efficient, and skillful manner, the A/E is to notify the PM immediately, is to submit a written assessment of any items of the work that are unsatisfactory.



Add one item to the list under “Design Development A/E deliverables”:

*Site demolition plan indicating trees and other significant vegetation to be removed or protected. If removals have changed from the Schematic Design Phase, a narrative should be provided indicating any changes to proposed mitigation.*

The A/E is responsible for the preparation of contract bulletins, supplemental instructions (including sketches or document revisions, if necessary), addenda to the project documents, and review and approval of shop drawings, samples, warranties, and guarantees. The A/E is to transmit to the PM one copy of approved shop drawings and submittals immediately following their approval, and assist the PM in negotiation, preparation, approval, processing and recording of the cost and scope of change orders.

All significant changes during the construction phase that affect the visual or functional characteristics of the project design are to be brought to the attention of the PM immediately. Significant changes may require an additional presentation to the Project Committee and/or the Design Review Committee.

**A/E deliverables and responsibilities:**

- If drawings need to be issued in response to a scope change or to clarify design intent, the A/E will provide the PM and the Contractor with a description of the change and highlight (bubble) the extent of the change in the documents. The drawings, and a narrative description of the change if necessary, is to be accompanied by a transmittal reason for issuance;
- The A/E is required to respond promptly, in writing, to all Requests for Information (RFIs) from the Contractor according to timeframe defined in the Agreement. The response may require review and approval of the University. RFIs may require a field sketch. If the response from the Contractor indicates a change in scope or cost, the Contractor is required to submit a cost estimate and any anticipated changes in the project schedule to the PM and receive authorization to proceed prior to implementation;
- Construction or field sketches are issued to illustrate a change to the construction documents. Such sketches are to include a title block indicating the project name and number, a sheet number, date of issue, and a reference to the existing document being changed. These documents are to be accompanied by a transmittal indicating the reason for issuance. The A/E is to maintain a list of all construction sketches issued and is responsible for ensuring that the change is incorporated into the record documents;
- Field visits and field reports by the A/E are to be documented in a log kept by the A/E. The log is to indicate and record the A/E's required periodic visits to the construction site, including who visited the site, the date, and purpose of visit. A report is to be issued to the PM and copied to the Contractor indicating the status of construction and any findings of particular note or not in accordance with the construction documents;
- Certification of Substantial Completion: As the work nears completion, the PM will work with the Contractor to schedule a final inspection by the A/E. Prior to this inspection, the Contractor will develop a list of items to be completed or corrected (i.e. punchlist) and fix the time within which the items are to be competed. At the final inspection, the A/E is to review all aspects of the project, including the punchlist items, for their conformance with the contract documents, and make the following determination:
  - The project is complete and accepted;
  - The project is accepted subject to completion of the items listed (i.e., punch list);
  - The project is not complete and another date for a final inspection will be set.

  The A/E is to work with the Contractor as directed by the PM to achieve satisfactory project completion as defined in the Agreement.
- At the close of the project, and as a condition of final payment to the A/E, the A/E is to deliver to the PM a complete package of record documents, which is to include a complete set of project drawings and specifications, incorporating changes or updates from every discipline and sub-consultant. Documents are to be provided in accordance with the Documentation Format and Graphic Standards, the last section of this document.

***Post-Occupancy Studies:*** At the conclusion of a project, the University may elect to commission an A/E team to execute post-occupancy studies or reports. Deliverables, scope, and format of such studies or reports are to be defined by the University to meet specific project needs, and are typically carried out under a separate contract.

**Building Commissioning**

Commissioning is the process of ensuring that building systems are designed, installed, functionally tested, and capable of being operated and maintained as designed to meet the University's needs. Retro-commissioning is the process of evaluating and upgrading systems in existing buildings to restore high performance.



Add one item to the list under "Construction Administration Phase A/E deliverables and responsibilities"

*The A/E will notify the PM promptly if site disturbances are observed outside of the limits of the area of disturbance, or within tree protection zones. This includes any removal of tree protection fencing and activities or foot-traffic within tree protection fencing.*

The intent of commissioning is to provide:

- Precise adjustment of HVAC systems and controls;
- Better building documentation;
- Improved training of building operators;
- Shortened occupancy transition period;
- Lower operation and maintenance cost;
- Lower utility bills; and
- A healthier and more comfortable work environment.

For complex projects, the University prefers that a commissioning agent be hired distinct from the Contractor and lead A/E firm. Commissioning requirements for each project are to be determined at the project inception, and the A/E is to document the commissioning requirements as part of their basic services. During the design and construction phases, the A/E is to assist the commissioning agent as part of the A/E's basic services.

**Sustainability Policy**

The University is committed to creating a campus environment that moves beyond merely sustainable, to one that actively improves the quality of life and the environment for its users. The A/E is to support the University's goals by providing design services that:

- Reduce dependence on non-renewable resources by using products with recycled content and by promoting adaptive reuse of existing structures. On-site separation and recycling of construction and demolition debris is required for all projects;
- Reduce transportation costs by selecting locally manufactured products;
- Site new structures mindful of orientation, shading, and the effect on adjacent buildings and spaces;
- Create healthy, pleasant outdoor environments that reduce exterior lighting demand and minimize stormwater runoff;
- Minimize maintenance and operating costs by integrating innovative building systems engineering approaches at inception of the project;
- Improve indoor environmental quality by selecting adhesives, coating, and paints with low content of volatile organic compounds (VOCs);
- Maximize building flexibility to satisfy the varied demands of current and future users and residents;
- Reduce energy consumption through the use of appropriate technology (natural cooling, daylighting, passive solar design, and so on.)

The sustainability goals of each project will be defined at the outset of the design process.

**Additional Design Issues**

The University requires that A/E firms adhere to and incorporate the following additional design and documentation standards and practices into all of their work.

***Long-Term Planning:*** The A/E is to keep in mind that decisions regarding design, materials, and methods of construction are to be considered as part of long-term improvements to campus. Cost effectiveness is to be considered over the life of the project, unless directed otherwise. Site planning by the A/E is to consider existing and proposed facilities, infrastructure, and services, natural topography, and potential future development as articulated in the *Penn Design Guidelines and Review of Campus Projects*. (http://www.facilities.upenn.edu/uop/BldgDesignGuidelines.pdf)

***Materials and Equipment Selection:*** Materials specified must be durable and readily available, and are to be chosen with environmental considerations in mind. Materials and systems are to be selected with regard to:

- Aesthetics;
- Durability;
- Safety;
- Cost effectiveness;
- Maintenance, access, and ease of replacement;
- Availability of warrantees, service personnel, and manufacturer's support;
- Use of standard parts, similar to comparable equipment/materials in use on campus;
- Availability of training for University personnel for operation and maintenance;
- Low life-cycle costs;
- Low use of energy or resources in construction;
- Environmentally sustainable disposal method at the end of the anticipated life cycle;



Add the following bullet point: under "Sustainability Policy":

***Enhance the ecological value of the campus landscape by minimizing damage to valuable trees and vegetation, and introducing diverse native-based plant communities.***

- Local availability.

***Support space requirements:*** The A/E is to identify space for all custodial, delivery and loading, storage, and recycling and waste removal functions. Mechanical rooms, support rooms, and corridors are not to be identified or specified as habitable spaces or storage rooms. Rooms used for teaching, or by staff or faculty, are to have exterior windows. Staff break rooms or lounges are to have operable windows that open to the outside wherever possible.

***Life Safety / Code Compliance:*** The A/E is to provide proper planning, design, and documentation to meet the requirements of all applicable codes, laws, and regulations, and provide all documents necessary for submission, review, and approval by the Philadelphia Streets Department, the City Planning Commission, the Philadelphia Zoning Board, the Philadelphia Department of Licenses and Inspection, and/or other regulatory agencies having jurisdiction. Permit documentation is to be clearly labeled as such, dated, and signed and sealed by the A/E as required. The architect is to fully support the University in its procurement of all relevant regulatory approvals.

Permit and zoning applications are made by the Office of the University Architect and coordinated by the PM. If the authority having jurisdiction requires additional documentation or requests changes to the submitted documents, the A/E is to work with the Office of the University Architect to complete this process in a manner acceptable to the University.

Factory Mutual is the insurer of University facilities, and projects are to be designed to meet all standards required. The A/E is to submit projects to the PM for Factory Mutual review as directed, and the A/E is to incorporate into the project documents any changes suggested as part of this review process.

***Accessibility:*** The A/E is to refer to the Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG) as the design standard for accessibility. The University is committed to becoming a barrier-free campus, and is working to remove and prevent all physical barriers to accessibility to all University spaces and landscapes.

In renovations and new projects on campus, the design goal is to provide a means to access all spaces without assistance or special knowledge, and without segregating persons in wheelchairs from the general population. For this reason, the construction of permanent accessible ramps along typical paths of travel is required at any changes in level inside buildings or in the landscape. Reliance on wheelchair lifts or other mechanical devices to negotiate changes in levels is not acceptable. Likewise, cardswipes for operations of doors using student and staff identification cards is preferred over keypad devices, which can be difficult to operate for persons with limited manual dexterity. Where pushpads are required for automatic operation of doors, both a hand-height pad and a foot-height pad (for use by persons who use a wheelchair but have limited arm and hand mobility) are both to be installed.

The project documentation is to include instructions to the Contractors to maintain all required accessible routes for persons with disabilities in or adjacent to the project site, including public pathways, interior corridors, accessible building entries, accessible toilet facilities, and accessible parking spaces. Special care is to be taken to ensure that temporary modifications of public pathways and/or corridors during construction are carried out in a manner consistent with the requirements of the ADAAG, including such aspects as clearances, changes in grade, steps, or obstructions. Where required, the contractor is responsible for installing signage, compliant temporary ramps, handrails, and/or other related items to ensure accessible routes are maintained.

***Accommodation of diverse populations:*** The University is committed to providing accommodation to meet the diverse needs of its community. Design professionals are to consider the following in all new buildings, particularly buildings that serve a public function:

- A gender-neutral unisex toilet equipped with a baby-changing station, signed accordingly. Note that if a flip-down diaper-changing table is located in an accessible toilet, it cannot obstruct the space required by a person using a wheelchair, and such tables must be accessible to people with disabilities. Gender neutral toilets accommodate both parents with small children and persons with non-normative gender identities;
- Incorporate lockable, private rooms that can be used for breast-feeding or routine medical procedures (such as insulin injections, checking blood-sugar levels, and so on). Such rooms are to be equipped with a comfortable armchair or daybed, with electrical power available adjacent to the chair.

These recommendations can be accommodated in new buildings at minimal cost, by locating unisex toilets



Add the following sentence under “Support Space Requirements”:

*The A/E will also consider landscape maintenance needs including access to water, power, and storage of tools as applicable.*

(which also meet ADA requirements and can be made to accommodate baby-changing stations) near to a ground floor public space, and providing places nearby that afford the privacy required for breast feeding or minor, self-administered medical procedures. Design decisions regarding these matters are to be made in the context of added costs, user demand, long-term maintenance, and security.

In existing buildings, design professionals are to incorporate these accommodations, subject to the same considerations, during major renovations, and/or when toilet rooms are updated.

Where possible, in new buildings and renovation projects involving showers, locker rooms, or changing rooms, accommodation should be made to include single-person shower facilities independent of male or female specific spaces.

In all such private and lockable rooms, a panic alarm system is to be installed, integrated with the building security system, to allow users to call for emergency assistance.

***Historic Buildings Requirements:*** The Philadelphia Historical Commission has certified a number of campus buildings as historically significant. Prior to beginning design on any such building, the PM is to schedule a meeting with the Cultural Resources Sub-Committee to review the proposed scope of changes to the building. Further meetings with this sub-committee may be required at every phase of the design and construction. For such projects, a preservation consultant is to be included in the A/E team for the duration of the design and construction process, as a fully integrated team member. The consultant's qualifications are to be reviewed and approved by the Office of the University Architect.

When undertaking renovation projects to buildings that have a significant historical character, the A/E is to engage a consultant with expertise in preservation and building conservation to carry out preservation services as part of the A/E team. The A/E is to work with the preservation consultant to ensure that the preservation goals are included as part of the project documentation, and executed during construction.

- All projects involving work on exterior masonry facades are required to obtain and record with the Office of the University Architect a mortar analysis to determine the original mortar color and composition. The analysis is to document joint detailing and profile as well as composition and pigmentation. Different samples are to be taken at each successive phase of construction of the existing building.
- All projects that involve replacement of doors or windows are required to obtain and record with the Office of the University Architect a paint and finish analysis to determine the original appearance of these elements. Special attention is to be paid to profiles of sashes, surrounds, and frames, so that an exact match is obtained for any replacement or restoration of windows or doors.
- If applicable, the A/E, working with the Office of the University Architect, is responsible for attaining approvals from the Philadelphia Historical Commission for all exterior work.

***Landscape Architecture:*** All projects that include a significant landscape architecture component (as defined by the Office of the University Architect), are to employ a landscape architect as an integral part of the A/E team for the duration of the project. Landscape architects are expected to adhere to the University's landscape standards for all work, and work in consultation with the University Landscape Architect.

**Utilities and Building Systems**

Water and gas service, chilled water, steam, fire suppression, storm and sanitary drainage, electrical service, and building mechanical service (including heating, ventilation, and air conditioning), and all other systems are to be provided by the most economical and accessible means, considered over the entire life-cycle of the building or renovation. For specific standards and guidelines, the A/E is to refer to *The Mechanical and Electrical Standard Design Guidelines* (http://www.facilities.upenn.edu/getDone/designguides.php3).

***Guaranteed Pavement Information System (GPIS):*** The University of Pennsylvania, in compliance with the City of Philadelphia Right of Way Management Ordinance (City Bill No. 050056), is working with the Department of Streets Right of Way Unit and its Guaranteed Pavement Information System (GPIS) regarding the design and installation of underground utilities in the public right of way.

As the Owner's agent, the Design Professional's services are to include representing the University by applying for and conforming to the GPIS system for all new and modified underground utilities proposed in a City of Philadelphia public right of way (as defined by GPIS).





***Drainage System:*** The storm water, roof drainage, sub-soil drainage, and building waste-water system designs are to provide for the specific requirements of the project, taking into account the existing sub-soil water table levels and the capacity of the existing sewer and drain system. This information is to be coordinated with the foundation and basement waterproofing systems. Permeable paving and vegetated roof systems are examples of ways to reduce storm water runoff.

***Electrical & Tele / Data Systems:*** The electrical system is to provide for power, lighting, tele/data communication systems, fire alarm systems, and all requirements of public safety. Many laboratory and other buildings that house critical functions are required to have dual electric feeds and/ on-site emergency power to critical equipment or locations, in addition to standard life-safety and emergency power requirements. All work is to be coordinated with key University stakeholders, such as the Office of the University Engineer, Fire and Emergency Services, Public Safety, and Information and Computing Services.

***Steam Distribution System:*** Steam is available throughout the campus at high or medium pressure, depending on the location. The high-pressure lines are 170-225 psig. The medium pressure lines are 70-110 psig. To the extent possible, the A/E is to incorporate the use of this system, with central monitoring and control, as directed by the University Engineer or PM. Since most University facilities have some minimal summer steam requirement (for reheat, domestic hot water, sterilization, etc), the A/E is to design to provide for steam system capability to meet both the summer and winter loads in an efficient manner.

***Heating, Ventilation, and Air Conditioning Systems:*** All new buildings are to be fully air-conditioned. The University Engineer is to review and approve the specified HVAC system. Each HVAC plant or method of air distribution is to be designed for maximum economy and efficiency. All systems must tie into University-wide control monitoring system. The A/E is to incorporate the existing central chilled water systems into all projects to the greatest extent possible.

All exterior mechanical equipment is to be shown to scale on all elevation drawings prepared by the A/E, from preliminary design to final construction documents. If the final size is not known during document preparation, the A/E is to show the largest possible size that may be used.

The A/E is not to locate exposed equipment on roofs. Exhaust fans, cooling towers, air handling units, and other HVAC equipment are to be incorporated into the body of the building or within penthouses, and air exchange is to be effected through louvers incorporated into the building and consistent with its aesthetic character. Cooling towers and air-handling units are not permitted to be visible from any place on campus or from other buildings. Window units are not to be specified.

***Security Systems and Emergency Response:*** Coordinate with the University's Division of Public Safety to incorporate security systems required by the University, including alarm systems, fire alarm and fire suppression systems, and emergency communication systems. The A/E is to coordinate documentation using the university's preferred system providers for design and installation details.

***Utility Shut Downs and Installations:*** All contract documents are to make clear that no University utility, including water, steam, chilled water, and electrical service will be turned on or off by any Contractor without the express permission of the Office of the University Engineer, conveyed by the PM. No new service equipment is to be installed and turned on without first properly installing and calibrating metering devices. The PM can provide detailed utility and/or building shutdown procedures, issued by the Operation & Maintenance Department of the University's Division of Facilities and Real Estate Services, that are to be referenced in project documentation and followed for all shutdowns.

***Maintenance / Equipment Access:*** The design of doorways, ramps, driveways, and passageways are to ensure that all equipment can be removed and replaced without removing any walls, doors, or other equipment, and that trucks and cranes can be employed at the point of exit. The design is to allow safe, adequate passageways for servicing of equipment. The A/E's design is to avoid the use of sealed hatches, and provide room for service access to all items and space for a workbench in major mechanical rooms. The A/E is to show tube pull, removal routes, and so forth on the drawings. A dedicated freight elevator may be required to serve upper-level mechanical rooms.

System control and electrical panels must be located at working height and well lighted. Ventilation is to be provided to maintain comfortable working and operating conditions for equipment. The A/E is to minimize locating any mechanical equipment in ceiling spaces, including valves and dampers. If any such items requiring

service must be located above the ceiling, the ceiling must have permanent markers indicating locations, and the ceiling must be removable with no concealed spline.

**Documentation Format and Graphic Standards**
All written documentation is to be submitted in Microsoft Word electronic format. Submissions may be on Zip discs or on CD, labeled accordingly. Paper copies are to be provided as determined during the project initiation meeting or according to the Agreement.

***Schematic Design, Design Development & Construction Drawings:*** Electronic files are to be submitted in TIFF (4) or AutoCAD format. (See TIFF and CAD requirements below). Submissions may be on Zip discs or on CD, labeled accordingly. Paper copies are to be provided as directed by the PM.

***Context requirements for exterior renovation or alteration projects:*** Documentation of projects that involve changes to the appearance of building exteriors are to include scaled drawings of the entire facade of the building, including all floors and penthouses or equipment above grade and the full width of the facade under consideration. New work is to be noted and clearly identified graphically to describe the scope and extent of external alterations. This requirement applies to such work as louver replacement, security screens, exterior lighting, telecommunications work, painting, finishes, and restoration, in addition to other exterior work. If directed by the PM, the A/E may be required to produce sight-line studies to analyze the views of new work from various points along campus walks or from other buildings.

***Key plans for interior renovation or alteration projects:*** Documentation is to include a key plan locating the project within its building and noting the floor on which the project is located.

***As-Built and Record Drawing:*** Record drawings and documents are to be supplied in ALL of the following forms.

- Full size hardcopy blackline prints; either bond or vellum.
- AutoCAD R14 or 2000 electronic format. (See CAD Requirements)
- TIFF(4) scanned image file. (See TIFF requirements, below. Note that .jpg files are not acceptable. Design professionals wishing to submit .pdf files are to provide a sample to verify that it is acceptable to the University.)
- Microsoft Word (for written documents and specifications)

Electronic submissions may be on Zip discs or on CD, labeled accordingly. Drawings are to be labeled to reflect Record or As-Built status.

***Content Requirements of As-Built and Record Drawing:*** The coversheet or first sheet of each drawings set is to include:

- Complete project title, including the client school or center;
- Location of the project, including a key plan;
- Project identification number provided by the PM;
- Numbered list of drawings with titles;
- Complete names and addresses of consultants and sub-consultants;
- Governmental agencies involved in the project, if any;
- Date.

Other requirements for As-Built and Record Drawing sets include but are not limited to:

- Room numbers on drawings must reflect those ultimately used in the spaces;
- Diagrams of all piping systems, including but not limited to condenser water, chilled water, refrigerant, steam and condensate, radiation, heating coils, fire lines, domestic water, and drains. Show all valves, gauges, strainers, meter, and other appurtances;
- Diagrams of each air handling system, including main duct runs, in the form of a riser diagram or isometric. Provide the sizes of main ducts as an aid to identification;
- Schedules of all mechanical, electrical, and plumbing equipment are to indicate capacities, heads, electrical characteristics, flow rates, and other critical data. Identify each unit by number, duty, and area served;
- Automatic Temperature Control systems schematic diagrams are to indicate control sequences on drawings and specifications, and an explanation of specialized systems and materials.

***TIFF File Requirements:*** Scanning of drawings is to be performed at a resolution of 200 DPI, two color (black and white) depth, despeckled to indicate no less than 4 pixel original representation, axis skew aligned to within 5% of original line angle direction with image scale expansion not to exceed 3% of original in the scanner



Add the following sentence within “Context requirements for exterior renovation or alteration projects”:

*The A/E shall also consider potential negative impacts to surrounding vegetation to inform additional protection or mitigation as part of the project.*

device feed direction. All original black and color markings are to be recognized and rendered by the scanning and digital enhancement process with no less than 95% of the quality retained by the second image and 0.02 inch line definition retention. The resolution of these TIFF files are to be such that the cross section of each and every line is to never be less than three pixels in width.

Scanned files are to be made from hard copy prints of drawings considered by the A/E to be the final and definitive version, to include all title block and signature information. Scanned files may be electronically converted from CAD files provided title block information is complete and plotted scanned file is identical to hard copy plot from original CAD file.

Scanned file names are to be 21 characters and consist of three data groups separated by a dash. Zeroes are to be inserted to the left of each data group to meet required character length. First group is to be 5 characters and contain the approved Penn "Building Number." Second group is to be 6 characters and contain a "P" followed by the Penn project number. If a project number is not available, enter the year followed by the month for the most recent drawing date. Third group is to be 8 characters and contain the unpunctuated drawing number (not the CAD filename). Begin from right for drawing numbers exceeding 8 characters.

Examples: 00310-P00102-000000A1 (drawing w/ project number)
02090-200502-00000P14 (drawing w/o project number)

***CAD Drawing Requirements:*** Layering, layer naming and file naming of CAD submissions for Record Drawings are to be documented and provided by the A/E. Submissions are to conform to the American Institute of Architects CAD Layer Guidelines, Second Edition. Sheet Files are to be provided for each hard copy drawing comprising the final drawing set. A separate file is required for each sheet. The origin of a sheet is to be located at the lower left outside corner of the sheet border. A sheet is not to contain any information placed outside of the sheet border.

All layers required for correct plotting of a sheet, and only those layers, are to be visible when the sheet is saved prior to delivery. All XREF's, blocks, images, overlays, etc., are to be "bound" to each sheet file to include all borders, common floor plans, and complete title blocks, and drawings are to be purged of all unused layers, blocks, and components before submission to Penn. Where possible, all text fonts are to be chosen from those supported by AutoCAD R14 or 2000. Other supplied CAD files (3-D, sketches, etc) are to be contained in a separate folder or other location apart from the CAD construction documentation files.

***Space Management CAD Files***
In addition to Record Drawings, the A/E is to supply Space Management CAD floor plan drawings in electronic format for new construction or any renovation that substantially changes the room layouts for more than 2500 square feet on a given floor. Space Management floor plans are required as soon as new room layouts are finalized and at least six weeks before the space can be occupied.

Floor plans are to be drawn at full scale and include room numbers and names or functions. Each drawing sheet is to contain only one complete floor plan, centered in the drawing field.

*Space Management CAD Files Detailed Requirements*

- CAD file names are to be configured as "building number" FLR "floor number." Example: 580FLR1.
- Room numbers and room descriptions are to be centered in the space they refer to. Text height for room numbers and room descriptions are to be 12 inches.
- Closed polylines are to be used to enclose the internal area of each room and space. A closed polyline is to be used to enclose the external area of each floor.
- Floor plans are to be oriented parallel or perpendicular to sheet borders so that north is generally at the top of each sheet.

Layering and color requirements for drawing elements are to be in accordance with Table A.

Table A:

| Layer Description | Color | Layer Name |
|---|---|---|
| Room Description and Number | Magenta | Room_text |
| Shafts, Walls | Red | All_walls |
| Polylines | Green | Polylines |
| Stairs/Elevators/Railings | Blue | Stairs_elevators |
| Windows | Yellow | Windows |
| Doors/Swings | White | Doors |
| Fixed Equipment/Plumbing Fixtures | Cyan | Equip |
| Casework | Red | Casework |

***Campus Utility Map Updates***
The Office of Data & Documentation, within the Office of the University Architect, maintains an updated campus utility map. At the close of each project that involves changes to the external routing, arrangement or location of any utility on campus, the A/E is to prepare AutoCAD drawings, derived from the campus utility map, to allow for updates by the Penn facilities staff.

The utility information is to include, but not be limited to: electrical power, steam, chilled water, telecommunications wiring, water supply, stormwater systems, sprinkler piping, sewers and gas lines. Updated documentation is also to include duct banks, underground wiring or utility pathway, sizes, substations, manholes, descriptive text and other changes to utility services. CAD files shall utilize the layering system, line types, symbology and all other characteristics of the campus utility map. New utility information shall clearly indicate where changes have been made.

***Operation & Maintenance Documentation/Products and Materials Summary***
The A/E's specifications are to require contractors to deliver O&M manuals to the PM as part of the project closeout documentation. These manuals not need to be supplied in electronic format. All material is to be delivered in a 3-ring binder labeled on the cover and spine with pertinent information related to the project. The manual is to contain an index sheet(s) listing material included for each division, arranged numerically by division. The manual also is to be tabbed to separate each division. Each Contractor may submit a separate O&M manual covering only his divisions provided material is configured as described above. Product information supplied separately bound by the manufacturer or vendor does not have to be included in the binder provided it is adequately identified with project and division.

***Products and Materials Summary***
As part of the closeout documentation for capital projects, the A/E is to submit a Products and Materials Summary spreadsheet, as directed by the University Project Manager. A sample spreadsheet is available at http://www.facilities.upenn.edu/uop/Products&materials.xls . These forms can be modified as required for specific projects, but are to list manufacturers, equipment types and model numbers, finishes, and building components to facilitate minor repairs and alterations carried out by the University.

***Other Information***
All photographs, models, sketches, and renderings prepared in the course of the design or as an additional service are the property of the University and are to be delivered at close-out or before, unless otherwise noted in the Agreement. Materials prepared electronically are to be submitted in CAD, or other format as approved by the Office of the University Architect at the time of presentation. (See CAD Requirements.) Electronic submissions may be on Zip discs or on CD, labeled accordingly.



Add the following sentence within "Operation and Maintenance Documentation/Products and Materials Summary":

*O&M manuals should address all interior building functions as well as site facilities such as vegetation, irrigation systems, and stormwater facilities.*

# GREEN GUIDELINES FOR RENOVATIONS

**Purpose of these guidelines:**
The intent of these guidelines is to improve environmental practices for building renovation projects across campus, including the Morris Arboretum, the New Bolton Center, UPHS projects, and Penn Real Estate Projects. The Guidelines are to be followed throughout all phases of applicable renovation projects, and apply to project design, specification, and construction.

**When to use the guidelines:**
At the outset of the project, and no later than the project kick-off meeting, the Project Team is to review the following matrix to determine applicability of these Guidelines.

| FIVE QUESTIONS | YES | NO |
|---|---|---|
| **1. Is the total project construction budget greater than $7 million?** | | |
| **2. Is the total renovated project area greater than 10,000 sq.ft?** | | |
| **3. Does the renovation project involve more than one building system (HVAC, plumbing, lighting, etc.)?** | | |
| **4. Does the renovation involve more than 3 specification divisions? (for example, Section 06 Wood, 09 finishes, 12 furnishings, etc.)** | | |
| **5. Will an outside design professional be hired?** | | |

If the Project Team answers YES to *all five* of these questions, the policy is to design, construct, and certify the renovation project to at least the Silver level under LEED™ for Commercial Interiors. In addition, any project with a construction budget over $4 million and 10,000 sf should be *considered* for LEED certification. Exception: If the project does not meet the USGBC's Minimum Program Requirements, the project is not required to meet LEED certification. The project boundaries and schedule are among the factors to be considered in determining the USGBC's Minimum Program Requirements.

If the Project Team answers YES to *fewer than five* of these questions, and the project construction budget is at least $100,000, University policy is to follow these Renovation Guidelines in lieu of LEED Certification.

**Project Kick-off Meeting:**
The Penn Project Manager will include a review of project goals, including sustainability goals, as part of the kick-off meeting agenda, and ensure that the project team is aware of all requirements of Penn's *Instructions to Design Professionals*. At the outset of the project, and no later than the project kick-off meeting, the Project Team shall identify a "Green Guidelines Coordinator" (GGC) for the project, as follows:

- For LEED projects, the A/E Team shall designate a member of the consultant team as a LEED coordinator who fulfills the duties as the GGC;
- For projects that require an outside design professional that are not seeking LEED certification, the design professional, or A/E, shall designate a member of their staff to fulfill the duties of the GGC;
- For projects that do not have an outside design professional, these responsibilities of the GCC will be performed by a designated member of the School / Center staff;
- For projects performed by the FRES O&M Small Projects Group, the GGC shall be designated by O&M management and the School / Center.



**Green Guidelines for Renovations**
*These guidelines are intended to identify the most important environmental criteria for use in project design, the selection of materials and products; and management and construction renovation projects.*

**01 General Requirements**

A. Policy Statement
   i. Guidelines are to be followed unless budget or schedule would be severely and adversely affected. When any deviations from any aspects of the Guidelines are identified, they must be justified by the School / Center project representative in a written document forwarded to the University Architect and the Penn Sustainability Director at the earliest possible time. This document is to be included in the project closeout documents.
   ii. Some Schools within the University have developed specific standards for design, engineering, and product selection that should be followed in addition to these University-wide Guidelines. The School-specific design standards are intended to be complementary to both the USGBC's LEED rating system and the University's Green Renovations Guidelines. In the event of any confusion or ambiguity, the GGC should review the issue with the Project Team at the earliest opportunity.
   iii. For projects that contain extensive matching of existing materials, finishes, or furnishings, the GGC should review the environmental performance of those existing materials for compliance with the Green Guidelines and present the information to the Project Team. When existing materials do not meet the Green Guidelines, the Project Team will determine if a wholesale replacement of the materials is justified, and/or if there is an alternate compliant material that could be used. Use of non-compliant materials is considered an exception to the Guidelines, and should be documented in the project file with an explanation by the GGC, and the explanation sent via e-mail to the University Architect and the Penn Sustainability Director.

B. Responsibility
   i. These Guidelines are referenced as part of the Penn *Instructions to Design Professionals*, and as such compliance with the Guidelines is the responsibility of all parties identified in Project contracts, including design consultants and subconsultants, contractors and construction managers, and project trades and service providers.
   ii. The primary consultants for design and construction are responsible for ensuring that all subconsultants comply with the Guidelines in terms of reporting, submittals, and providing the documentation required.
   iii. The Penn Project Manager is responsible for ensuring that the design consultants and construction/construction management team are apprised of and comply with these Guidelines, and is responsible for coordinating resolution of all questions arising from application of these Guidelines with the Project Team.
   iv. It is the responsibility of the Penn School and Center administrators to ensure that the project site is prepared for renovation, and to ensure that remediation of hazardous materials and site cleanup are either identified as part of the project scope or completed prior to the execution of the renovation work.

C. Maintenance Manuals and Instructions. The Penn Project Manager is to coordinate with Penn Area Managers and other key FRES staff to:
   i. Ensure that all building engineering and building systems information (such as engineering equipment operation manuals and maintenance recommendations) is provided to and received by appropriate Penn Operations and Maintenance personnel;
   ii. Coordinate training on all installed or purchased equipment with appropriate FRES and building administration staff;

iii. The Penn PM will coordinate with the contractor to provide submittal materials / guidelines for cleaning and maintenance of newly installed interior finishes with FRES Housekeeping leadership and the building administration staff.

D. Commissioning and Minimum Energy Performance. The GGC shall:
   i. Coordinate the goals for commissioning and energy performance with the project team at the start of the project, in consultation with the Penn Director of Engineering and Energy Planning in the O&M Department at FRES. If a consulting commissioning agent is part of the project team, this consultant is to be managed by the Penn Project Manager.
   ii. The project team is responsible for developing an energy reduction plan for the renovation in consultation with the Penn Director of Engineering and Energy Planning
   iii. Ensure that the design consultants follow the requirements for building systems set out in Penn's Penn Engineering Standards;
   iv. Ensure that the design consultants specify Energy Star rated equipment and appliances. (If Energy Star does not rate the type of equipment needed, products selected / specified must be in the top 25% of its type or classification.)
   v. Ensure that the design team investigates opportunities for Pennsylvania Act 129 energy efficiency rebates as part of all building system upgrades and replacements.

E. Indoor Air Quality during Construction
   i. The GGC shall ensure that the project specifications follow the recommended control measures of Chapter 3 of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings Under Construction, latest Edition.
   ii. Protect new and existing materials from moisture damage during construction.

F. Construction/Demolition Waste Management & Jobsite Recycling
   i. Recycle and/or salvage a minimum of 75% of nonhazardous construction and demolition debris.
   ii. A construction and demolition waste plan is to be coordinated with School or Center leadership at the start of the project, and is to include a list of all materials that are to be salvaged or reused within the project. The Contractor shall coordinate reuse, salvage, recycling, donation, and/or disposal of all equipment, furniture, and movable items within the project scope in coordination with the GGC.
   iii. Provide recycling and waste containers to accommodate the anticipated quantities of demolition and construction waste, and jobsite recycling, throughout the duration of the project. Recycling may include, and is not limited to, electronic and electrical waste (fluorescent tubes, lighting equipment, wiring, old equipment, and electronics), construction & demolition waste (drywall, carpet, lumber, ceiling tiles, metals, etc.), and jobsite waste such as bottles, cans, and cardboard, which can be recycled in Penn's single-stream recycling system. The GGC shall ensure there is an appropriate location for these containers in the project space during demolition, construction, and fit out, and follows the guidelines posted on the University's recycling website.
   iv. Construction and demolition waste quantities are to be reported monthly to the GGC and project Team. Reporting is to include, by weight, all waste delivered to landfills and all waste diverted from landfills through recycling, reuse, donation, composting, or other diversion strategies. All waste data, including recycling, donation, and other diversion strategies, are to be included in the Penn project close-out documents.
   v. The GGC is to collect all construction and demolition waste data and report monthly to the FRES O&M Urban Parks Director.

Add the following sentence under "Facilitating jobsite recycling"

*Any exterior locations for recycling and waste containers must respect the protection of existing vegetation as per Penn's Landscape Disturbance requirements, Division 32 Section "Landscape Disturbance Requirements."*

*Resources:*

***Ben's Attic*** *(for recycling office equipment & furniture within Penn): http://www.upenn.edu/almanac/volumes/v57/n13/attic.html*

***Revolution Recovery*** *(construction & demolition waste management): http://www.revolutionrecovery.com*

***E-Force Compliance*** *(for certified electronics recycling, universal waste, and construction/demolition waste): http://eforcecompliance.com/*

***Elemental, Inc.*** *(for electronics recycling) http://www.eleminc.com*

***The Habitat ReStore*** *(for furniture and unused building materials): http://www.habitatphiladelphia.org/habitat-philadelphia-restore/donate-restore*

G. Third Party Certifications to ensure indoor air quality of finished spaces: All furniture, furniture systems, carpets, resilient flooring, other flooring and floor covering, acoustic ceilings, paints, stains, coatings, caulks, adhesives, sealants, primers, and wall coverings used in Penn renovation projects shall comply with one or more of the following certifications and standards. If certifications are not available for specified product types, the design consultant is to verify that the products meet or are equal to the following standards for indoor environmental quality.
   i. BIFMA level Certification: level® is the multi-attribute, sustainability standard and third-party certification program for the furniture industry.
   ii. California Section 01350: offers guidance to ensure that pollutant concentrations in a finished space do not exceed certain maximum levels. The Collaborative for High Performance Schools (CHPS), a California-based consortium, maintains a list of products with pollutant emission rates that meet the standard.
   iii. CRI Green Label Plus: The Green Label Plus program from the Carpet and Rug Institute (CRI) identified carpets and pads tested to show very low emissions of VOCs. Adhesives must also comply.
   iv. Floor Score: FloorScore® was developed by the Resilient Floor Covering Institute (RFCI) together with Scientific Certification Systems (SCS) to test and certify flooring products for compliance with stringent indoor air quality emission requirements adopted in California.
   v. GREENGUARD Indoor Air Quality Certification Program: The GREENGUARD Indoor Air Quality Certification Program lists products that meet strict chemical emissions limits, which contribute to the creation of healthier interiors.
   vi. Green Seal GS-11: The Green Seal Standard for Paints and Coatings GS-11 establishes environmental requirements for paints and coatings.
   vii. Green Seal GS-47: The Green Seal Standard for Stains and Finishes GS-47 establishes requirements for stains and finishes.
   viii. NSF 140 Platinum: a rating system with varying levels of certification to define sustainable carpet.
   ix. South Coast Air Quality Management District Rule 1168 for coatings, adhesives, sealants, and primers.

H. Definitions
   i. Recycled materials terminology
      a. Postconsumer recycled material is defined as waste material generated by households or by commercial, industrial, and/or institutional facilities in their role as end-users of the project, and which can no longer be used for its intended purpose.



      b. Preconsumer recycled material is defined as material diverted from the waste stream during the manufacturing process. Reutilization of materials (i.e., rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it) is excluded.
   ii. FSC: Wood or wood products certified in accordance with the Forest Stewardship Council's principles and criteria
   iii. LEED-CI: USGBC's Leadership in Energy and Environmental Design for Commercial Interiors. Reference to LEED-CI in this document means the most current, applicable version.
   iv. VOC: Volatile Organic Compounds

**03 Concrete**

For interior concrete work, the intent should be to replace Portland cement (which has an extremely high carbon footprint) with a natural or recycled pozzolan to the greatest degree possible for the specific application. The design specification for interior concrete is to provide the following data:

A. The percentage of post-industrial pozzolan (fly ash, blast furnace slag, or other materials) cement substitution as a percentage of the full product composite by weight.
B. The percentage of post-industrial and post-consumer recycled content aggregate.
C. The percentage of post-consumer recycled steel content in each type of steel reinforcement as a percentage of the full product composite by weight.
D. The location where all products were manufactured and where the raw materials were harvested, extracted, or recovered.
E. For projects using reusable or FSC certified formwork, provide chain-of-custody documentation and other data as required.
F. MSDS product information data showing that form release agents meet any environmental performance goals.

**06 Wood and Plastics**

A. Composite wood and panel products (plywood, particleboard, etc.):
   i. Products shall have no added urea formaldehyde.
   ii. Panel adhesives shall be low-emitting with a maximum VOC content of 50 g/L.
B. Wood Trim, Custom Casework, Paneling, Veneer, etc.: Wood should be from FSC sources or from salvaged sources.
C. Location of harvest: Use wood harvested or salvaged within 250 miles of campus.
D. Countertops: Provide products that are GREENGUARD Indoor Air Quality Certified or whose emissions are less than the Full Levels listed in GREENGUARD Indoor Air Quality (IAQ) Standard for Building Materials, Finishes and Furnishings.

**07 Thermal and Moisture Protection**

A. Interior Sealants: Use interior sealants with a maximum VOC of 250 G/l[1] (as required to meet South Coast Air Quality Management District (SCAQMD) Rule 1168)

**08 Doors**

A. All existing doors should be evaluated for potential reuse as the preferred strategy in renovation projects.
B. For wood used in new doors: follow guidelines in Section 06.
C. Composite wood & panel products in doors: follow guidelines in Section 06.

[11] SCAQMD Rule 1168

* Exceptions to this requirement are to be documented in the project file with an explanation by the GGC, and sent via e-mail to the University Architect and the Penn Sustainability Director.

**09 Finishes**

A. Gypsum Board
   i. Specify synthetic gypsum board as preferred to virgin gypsum sourcing
   ii. Recycled Content: Preconsumer 10% minimum

B. Acoustical Ceiling Tile
   i. Recycled Content:
      a. Preconsumer: 10% minimum
      b. Postconsumer: 25% minimum
   ii. Reflectivity, in areas with windows: 90% minimum

C. Wood Flooring:
   i. See Section 06
   ii. Cork Flooring products must be GREENGUARD Indoor Air Quality Certified

D. Ceramic Tile: Recycled content, postconsumer: 25%

E. Resilient flooring, epoxy flooring, and other hard flooring
   i. All hard flooring must meeting the requirements of the FloorScore® standard or be GREENGUARD Indoor Air Quality Certified
   ii. Adhesives: see Section 09.H below for VOC content limits of adhesives
   iii. Use resilient sheet products with 35% recycled content, minimum (20% postconsumer).*
   iv. Recycled Content: Preconsumer ,10% minimum
   v. Epoxy flooring is to meet SQAMD Rule 1113 for VOC mixed compounds.

F. Carpet
   i. Use Products that meet CRI GreenLabel Plus and are certified to NSF 140 Platinum
   ii. Use products that have a minimum of 10% postconsumer recycled content
   iii. All carpet adhesives must have less than 50g/L VOC.

G. Carpet Backing
   i. Use Products that meet the CRI GreenLabel Plus
   ii. Recycled content: Postconsumer, 20% minimum
   iii. Use backing from a manufacturer that provides closed loop recycling.*

H. Adhesives: Use products that are GREENGUARD Indoor Air Quality Certified or use product with the following maximum emissions limits:

| ARCHITECTURAL APPLICATIONS | VOC LIMIT (grams /liter) |
|---|---|
| Indoor Carpet Adhesives | 50 |
| Carpet Pad Adhesives | 50 |
| Outdoor Carpet Adhesives | 150 |
| Wood Flooring Adhesives | 100 |
| Rubber Floor Adhesives | 60 |
| Subfloor Adhesives | 50 |
| Ceramic Tile Adhesives | 65 |
| VCT and Asphalt Tile Adhesives | 50 |
| Drywall and Panel Adhesives | 50 |
| Cove Base Adhesives | 50 |
| Multipurpose Construction Adhesive | 70 |

* Exceptions to this requirement are to be documented in the project file with an explanation by the GGC, and sent via e-mail to the University Architect and the Penn Sustainability Director.



I. Paint
   i. VOC: Paints and coatings must be GREENGUARD Indoor Air Quality Certified or have VOC content limits that meet those established in Green Seal Standards GS-11, Paints
   ii. Reflectivity: In spaces with windows, provide paint whose reflectivity is a minimum of:
      a. Walls: 80% reflectivity on at least 75% of wall surfaces
      b. Ceilings: 90% reflectivity
   iii. Clear wood finishes, floor coatings, stains, primers, sealers, and shellacs must be GREENGUARD Indoor Air Quality Certified or have VOC content limits that meet the South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, (summarized below):

| INTERIOR COATING TYPE | VOC LIMIT (grams /liter) |
|---|---|
| Clear Wood Finishes | 275 |
| Varnish | 50 |
| Sanding Sealers | 150 |
| Wood Flooring Adhesives | 100 |
| Lacquer | 60 |
| Floor Coatings, including epoxy coatings | 50 |
| Primer Sealers & Undercoaters | 100 |

**10 Specialties**

Toilet Compartments: Recycled content, postconsumer, 50% minimum

**11 Equipment**

A. All new appliances, office and lab equipment, mechanical equipment, windows, ceiling and exhaust fans, and other items shall be Energy Star labeled when such ratings exist.

B. Appliances and equipment that are more than 10 years old are to be replaced with Energy Star labeled units when such ratings exist

C. If Energy Star is not appropriate or applicable, specify the most energy efficient option which meets other requirements

**12 Furnishings**

A. Casework: See Section 06

B. Textiles
   i. Provide products that are GREENGUARD Indoor Air Quality Certified or whose emissions are less than the full levels listed in the REENGUARD IAQ Standard
   ii. Provide products with at least 50% postconsumer recycled content or 50% natural material.*

C. Window Treatments
   i. Provide products that are GREENGUARD Indoor Air Quality Certified or whose emissions are less than the full levels listed in the REENGUARD IAQ Standard
   ii. Products must be PVC-free
   iii. Recycled content: Postconsumer, 25%
   iv. Microbial and fungal resistant

* Exceptions to this requirement are to be documented in the project file with an explanation by the GGC, and sent via e-mail to the University Architect and the Penn Sustainability Director.

D. Furniture
   i. When appropriate, re-use existing or salvaged and refurbished pieces
   ii. All new office furniture must meet the requirements BIFMA **level®** certification or be GREENGUARD Indoor Air Quality Certified
   iii. All furniture must be PVC Free
   iv. Wood in furniture: follow guidelines in Section 06
   v. Where possible, provide products whose construction includes 50% easily recyclable parts.

Emissions: Contaminant emissions from furniture should not exceed the following limits:

| Contaminant | Emissions Units - Systems Furniture | Emissions Limits - Seating |
|---|---|---|
| TVOC | 0.5 mg/m3 | 0.25 mg/m3 |
| Formaldehyde | 50 parts per billion | 25 parts per billion |
| Total Aldehydes | 100 parts per billion | 50 parts per billion |
| 4-Phenylcyclohexene (4-PCH) | 0.0065 mg/m3 | 0.00325 mg/m3 |
| Table 12D. Indoor Air Concentrations Chemical Contaminant (from LEED-CI) | | |

**32 Mechanical**

Refer to Penn Engineering Standards

**33 Electrical**

A. Refer to Penn Engineering Standards
B. Other requirements:
   i. Daylight Controls: Install daylight responsive controls in all regularly occupied spaces within 15 feet of windows and under skylights. Daylight controls must switch or dim electric lights in response to the presence or absence of adequate daylight illumination.
   ii. Occupant controls: Consider individual lighting controls for regularly occupied spaced to enable adjustments to suit individual workstations and designing to a lower level of ambient lighting
   iii. Task/Ambient Lighting: Consider providing task lighting at individual workstations and designing to a lower level of ambient lighting
C. Lamp types: avoid use of incandescent bulbs. Consider use of high efficiency lamps / bulbs such as LEDs and compact fluorescents.

**34 Plumbing**

A. Refer to Penn Engineering Standards
B. Use EPA WaterSense listed fixtures where available and feasible

**35 Cleaning Materials**

A. Coordinate cleaning requirements and practices with Penn Facilities Area Manager.
B. Provide products that can be cleaned using the following guidelines for the maximum contaminant concentrations:

| Contaminant | Emissions Limits - Seating |
|---|---|
| Formaldehyde | 50 parts per billion |
| Particulates (PM10) | 50 mg/m3 |
| TVOC | 500 mg/m3 |
| 4-Phenylcyclohexene (4-PCH) | 6.5 mg/m3 |
| Carbon Monoxide (CO) | 9 parts per million and do greater than 2 parts per million above outdoor levels |
| Table 18A: Maximum contaminant levels for cleaning materials (From LEED-CI) | |

TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

B. This Section includes:

1. Installing tree protection system in the building construction access area.
2. Protection of existing trees during construction of the Project.
3. Pruning/tying back branches of existing trees that interfere with temporary or permanent construction by certified arborist.
4. Requirements for excavation in tree protection zones.
5. Requirements for grading in tree protection zones.
6. Removal of tree protection system to accommodate construction of landscape improvements.
7. Providing temporary protection during construction of landscape improvements.

C. Related Sections:

1. Division 01 Section "Temporary Facilities and Controls" for temporary site fencing.
2. Division 31 Section "Site Clearing" for removing existing trees and shrubs.

1.3 DEFINITIONS

A. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

B. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.



B. Samples for Verification: For each type of the following:

1. Organic Mulch 1-quart volume of organic mulch; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.

C. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.

1. Species and size of tree.
2. Location on site plan. Include unique identifier for each.
3. Reason for pruning.
4. Description of pruning to be performed.
5. Description of maintenance following pruning.

D. Qualification Data: For qualified arborist and tree service firm.

E. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.

F. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

G. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1. Use sufficiently detailed photographs or videotape.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

1.5 QUALITY ASSURANCE

A. Arborist Qualifications: ISA Certified Arborist or ISA Board Certified Master Arborist retained by the University and independent of employment by the contracting company

B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.

C. Preinstallation Conference: Pre-installation Conference: Conduct conference at Project site before tree protection and trimming operations begin, meet with representatives of authorities having jurisdiction, Owner, Architect, Landscape Architect, consulting arborist, consultants, and other concerned entities to review tree protection and trimming procedures and responsibilities.

1.6 PROJECT CONDITIONS

A. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

B. Do not direct vehicle or equipment exhaust toward protection zones.

C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil: Natural or cultivated top layer of the soil profile or manufactured topsoil; containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 1 inch in diameter; and free of weeds, roots, and toxic and other nonsoil materials.

1. Obtain topsoil only from well-drained sites where topsoil is 4 inches deep or more; do not obtain from bogs or marshes.

B. Topsoil: Imported or manufactured topsoil complying with ASTM D

C. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood
2. Size Range: 3 inches maximum, 1/2 inch minimum
3. Color: Natural.

D. Protection-Zone Fencing: Fencing fixed in position and meeting one of the following requirements.

1. Chain-Link Protection-Zone Fencing: See Div 01 Section 015000

a. See drawings for areas Chain-Link Fence

Penn
Facilities & Real Estate Services

TREE AND PLANT PROTECTION - 3
March 2011

Delete 2.1 B, replace with the following:

*B. Imported topsoil shall comply with the requirements of Division 32 Section, "SOILS".*

2. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 2-inch maximum opening in pattern and weighing a minimum of 0.4 lb/ft.; remaining flexible from minus 60 to plus 200 deg F; inert to most chemicals and acids; minimum tensile yield strength of 2000 psi and ultimate tensile strength of 2680 psi; secured with plastic bands or galvanized-steel or stainless-steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than 8 feet apart.

   a. Height: 4 feet.
   b. Color: High-visibility orange, nonfading.

E. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering and as follows:

1. Signs prohibiting access to tree protection areas shall be 10" x 12", made of weatherproof materials, with a bright yellow background and black letters reading "TREE PROTECTION AREA - KEEP OUT, CALL: xxx-xxx-xxxx TO REPORT VIOLATIONS", and shall be placed along each visible face of fence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

B. For the record, prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

3.2 PREPARATION

A. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

B. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated.

1. Apply 4-inch average thickness of organic mulch. Do not place mulch within 6 inches of tree trunks.

Penn
Facilities & Real Estate Services

TREE AND PLANT PROTECTION-4
March 2011

Provide the phone number for the current Urban Park Manager for reporting violations, replacing text as follows:

*1. Signs prohibiting access to tree protection areas shall be 10”x12”, made of weatherproof materials, with a bright yellow background and black letters reading “TREE PROTECTION AREA - KEEP OUT, CALL CRAIG RONCACE: 215-898-7202 TO REPORT VIOLATIONS”, and shall be placed along each visible face of fence.*

3.3 TREE- AND PLANT-PROTECTION ZONES

A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people and animals from easily entering protected area except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.

1. Chain-Link Fencing: Install to comply with ASTM F 567 and with manufacturer's written instructions.

B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Architect. Install one sign spaced approximately every **35 feet** on protection-zone fencing, but no fewer than four signs with each facing a different direction.

C. Maintain protection zones free of weeds and trash.

D. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

E. Maintain protection-zone fencing and signage in good condition as acceptable to Architect and remove when construction operations are complete and equipment has been removed from the site.

1. Temporary access to protection zone is permitted subject to preapproval by Landscape Architect if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

3.4 EXCAVATION

A. This work shall be performed under the supervision of an Arborist.

B. Do not excavate within tree protection zones without prior notification and approval of the Owner. Notify the Owner a minimum of 48 hours before excavation within tree protection zones. Stake and/or layout with paint marking the extent of excavation for review before excavating.

C. Watering shall occur several days before the excavations and the ground and soil shall be kept moist until soil is replaced over the roots. At the completion of installation of the piling and shoring, the tree and the disturbed area shall be irrigated.

D. Install shoring or other protective support systems to minimize sloping or benching of

E. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Division 31 Section "Earth Moving."

Penn
Facilities & Real Estate Services

TREE AND PLANT PROTECTION-5
**March 2011**

Penalties should reference University Standard Specification Section 32 01 90.33.1, as follows:

*D. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations as per the requirements in 3.8 Repair and Replacement.*

Provide additional information, replacing text as follows:

*D. Install shoring or other protective support systems to minimize sloping or benching of excavations onto the tree root zone.*

F. Trenching near Trees in protection zone: Where utility trenches are required within protection zones, air spade to expose tree roots. Do not cut main lateral tree roots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning in Section 3.5

G. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches back from new construction and as required for root pruning.

H. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

3.5 ROOT PRUNING

A. Prune roots that are affected by temporary and permanent construction. Prune roots and as follows:

1. Airspaid in location of proposed disturbance to expose roots. If roots are encountered and redirection is not practical, cut roots approximately 3 inches back from new construction using a sharp pruning clean saw or pruner specifically designed for tree pruning. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
2. Cut Ends: Do not paint cut root ends.
3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
4. The roots shall not be allowed to dry during excavation. Cover exposed roots with burlap and water regularly.
5. Backfill as soon as possible according to requirements in Division 31 Section "Earth Moving."

3.6 CROWN PRUNING TREE PRUNING

A. This work will be performed under the supervision of a certified arborist.

B. Prune trees to remain to remove deadwood or limbs interfering with minimum clearance distances required for the construction. Provide subsequent maintenance during Contract period as recommended by consulting arborist.

C. Pruning Standards: Prune trees according to ANSI A300 (Part 1) as follows:

1. Type of Pruning:

a. Clearance

Penn
Facilities & Real Estate Services

TREE AND PLANT PROTECTION - 6
March 2011

Trenching should reference University Standard Specification Section 32 01 90.33.1 as follows:

*F. Trenching near trees in protection zone: where utilities are required within tree protection zones, utilize directional boring or similar methods that minimize impact to tree roots. Where trenching is the only feasible option, follow the requirements of division 32 Section "TRENCHING NEAR TREES".*

Correct spelling to "***Air Spade***"

Replace with the following language:

*B. Pruning Standards: Prune trees according to ANSI A300, Part 1 (2017).*

*C. General*

*1. Pruning operations should remove no more living material than what is necessary to achieve the specified objectives.*

*2. Utilize the smallest diameter cuts that meet the pruning objective.*

*3. The number and size of cuts that expose heartwood should be minimized.*

(Continued on next page)

1) Tying Back: Whenever practical, limbs that may interfere with the construction of the building but not permanently contacting the finished structure shall be retained. It is preferred that these limbs be tied back rather than removed by pruning. When tying back, the limb shall be protected from damage from the rope or other means. If the duration of the tie-back will include the next growing season, a screw eye shall be installed in the limb to be secured and the anchor portion of the tree and secured by a corrosion protected wire or rope of sufficient strength.
2) Clearance Pruning: When tying back is not practical, the limb shall be carefully pruned back to provide minimum clearance for the construction or minimum clearance from the finished building.

b. Safety Pruning: The remainder of the tree shall be pruned targeting dead limbs or other dangerous limbs over 1 inch in diameter.
c. Discovery: Any dangerous condition noted during climbing, pruning, or other tree care operations shall be noted and reported immediately by the tree service firm for approval by the Consulting Arborist.

2. Specialty Pruning: Utility.

D. Cut branches with sharp pruning instruments; do not break or chop.

E. Chip removed tree branches and stockpile in areas approved by Owner.

3.7 REQUIREMENTS FOR REGRADING IN TREE PROTECTION ZONES

A. Do not grade within tree protection zones without prior notification and approval of the Owner. Notify the Owner a minimum of 48 hours before grading within tree protection zones. Stake and /or layout with paint marking the extent of grading for review before grading.

B. Grade Lowering: Where new finish grade is indicated below existing grade, slope grade away from trees, unless otherwise indicated.

1. To minimize root damage, comb soil with narrow-tine spading fork to expose roots. Lift and wrap roots as noted herein. Lay roots on final subgrade and cover with topsoil.
2. Prune roots as noted herein.

C. Minor Fill: Where existing grade is 6 inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

Penn
Facilities & Real Estate Services

TREE AND PLANT PROTECTION - 7
March 2011

(continued from previous page)

*4. The final pruning cut should leave adjacent bark firmly attached.*

*5. Interior and lower branches should be retained when compatible with pruning objectives.*

*6. When removing live branches, the majority of cuts should be in the outer portion of the crown.*

*D. Clearance Pruning: Prune trees as required with the objectives of providing clearance to provide access to site or structures as required for construction. Provide subsequent maintenance during Contract period as recommended by consulting arborist.*

*1. Branches growing toward specified clearance areas shall be reduced to lateral branches or removed to parent stems growing outside and/or away from the clearance area (directional pruning).*

*2. When a minimum clearance distance is required, a branch removal or reduction cut should be made beyond the specified clearance distance at a suitable branch union.*

*3. When a reduction cut cannot be made to a suitable lateral branch, and to avoid an unnecessarily large pruning cut at the parent stem, a heading cut should be considered.*

Omit this section- regrading should never occur within Tree Protection Zones.

3.8 REPAIR AND REPLACEMENT

A. Promptly repair trees damaged by construction operations within 24 hours. Treat damaged trunks, limbs, and roots according to arborist's written instructions.

B. Remove and replace trees indicated to remain that die or are damaged during construction operations that arborist determines are incapable of restoring to normal growth pattern.

1. Provide new trees of same species as those being replaced; plant and maintain as specified in Division 2 Section "Exterior Plants."
2. Provide new trees of same size up to 6-inch caliper size. Plant and maintain new trees as specified in Division 2 Section "Exterior Plants."
3. When damaged trees requiring replacement are more than 6 inches in caliper size, measured 12 inches above grade; the CTLA Trunk Formula Method shall determine the replacement value.

3.9 REMOVAL OF TREE PROTECTION SYSTEM AND TEMPORARY PROTECTION

A. The method by which the tree protection system is removed shall ensure that vehicular access is strictly limited to those portions of the building construction access area that have the full tree protection system in place. After removal of protection materials, foot traffic only is allowed in the building construction access area, unless temporary protection measures are approved.

B. Remove tree protection system during the completion of the building construction to facilitate construction of the Landscape Improvements portion of the project.

C. Remove root protection materials in a manner to not disturb existing grade beneath the filter fabric.

D. Provide temporary fencing to secure the building and site and to restrict pedestrian and vehicular traffic through the tree protection zone during construction of the Landscape Improvements. Provide temporary measures to minimize compaction of soils within the tree protection zone.

3.10 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove excess excavated material, displaced trees, trash and debris, and legally dispose of them off Owner's property.

END OF SECTION

Penn
Facilities & Real Estate Services

TREE AND PLANT PROTECTION - 8
March 2011

Insert language for restorative pruning as "B." and update the lettering thereafter accordingly:

*B. Restorative Pruning: Where damage has occurred to trees as a result of construction activities, prune trees with the objective of developing structure and restoring plants from damage.*

Require an inspection at the end of construction to determine repair/replacement. This should include a review of the protected trees the following growing season.

*4. Penn will engage an arborist to perform a post-construction assessment of protected trees upon completion of the work. Any required replacement or payment of maintenance bonds identified by the arborist's inspection will be the responsibility of the contractor. The contractor will also be notified of any trees with marginal damage.*

*5. Penn will engage an arborist to perform a follow-up assessment one year after the completion of the work, assessing any trees previously identified as having marginal damage. Any required replacement of these trees or payment of maintenance bonds will be the responsibility of the contractor.*

Reword from *"restrict"* to *"prevent"*

Reword from *"minimize* to *"prevent"*

# Appendix C

## *SOILS SPECIFICATION*

Following is a new soils specification for inclusion in Penn's standard specification manual.

These specifications provide options for both imported soils and amended soils, depending on a given project's requirements and budget. The imported soils are based on the design of soils at Shoemaker Green. These soils are highly resistant to compaction and very effective at stormwater infiltration. This option is best for high-profile conditions where soils need to be very resistant to compaction and a greater investment can be justified. Amended soils are based on best practices for soil amendment: relieving subsoil compaction, improving organic matter through high quality compost, and balancing nutrient levels.

These soil designs provide Penn with the basis for healthy, high functioning soils throughout campus. Combined with well designed plant communities, these soils will improve stormwater infiltration, support a range of beneficial microorganisms, and support healthy plant growth without chemical inputs.

**PLANTING SOILS**

**NOTE TO A/E: Adapt these specifications to the specific requirements of the project. Penn encourages dialogue with the University Landscape Architect and Urban Parks in the final development of specifications.**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All of the Contract Documents, including General and Supplementary Conditions and Division 1 General Requirements, apply to the work of this Section and are hereby made a part of this Section.

1.2 SCOPE OF WORK

A. The work of this Section consists of all site preparation work and related items as indicated on the Drawings and/or as specified herein and includes, but are not limited to the following:

1. Decompaction of subsoils
2. Amendment of native soils
3. Production of manufactured planting and bioretention soils
4. Installation and placement of soils

1.3 RELATED WORK UNDER OTHER SECTIONS

A. Carefully examine all of the Contract Documents for the requirements that affect the work of this Section. Specification Sections that directly relate to the work of this Section include the following:

1. 31 20 00 – EARTHWORK
2. 32 01 90 - TREE AND PLANT PROTECTION
3. 32 92 00 – LAWN AND GRASSES
4. 32 92 01 – MEADOW SEEDING
1. 32 93 00 – PLANTS

1.4 DEFINITIONS:

A. Compaction: Compaction of the soil fabric is any force applied to the soil that reduces porosity and where 90 percent of all compaction can be accomplished with only three applications of force under optimum soil moisture conditions.
B. Dry Soil: The condition of the soil at or below the wilting point of plant available water in which the soil is powdery and subject to blowing.
C. Frozen Soil: The point at which the soil water has frozen and the soil has become very hard and cloddy. Ice crystals can be seen in the pore spaces of the soil.
D. Field Capacity: The percentage of water remaining in a soil two or three days after having been saturated and after free gravimetric drainage has ceased.



E. Moist Soil: The condition of the soil in where it can be formed into a ball and maintain its shape. Deformation of the soil is difficult with hand pressure. Free water is not visible and is usually considered the point between the wilting point and field capacity of the soil.
F. Wet Soil: Soils that are easily deformed by hand pressure and maintain their shape, and free water is visible within the pore spaces. The water content at this soil condition is considered at field capacity or wetter.
G. Saturated Soil: meaning that all the pore space within a soil is filled with water and the remaining water is under gravitational forces to drain through the profile.
H. Scarification: The loosening of the surface of a soil lift by mechanical or manual means to alleviate compaction of the soil surface. Depth of scarification is dependent on material and extent of compaction.
I. Subgrade: The in-situ soil material that the planting soil will be installed upon.
J. Topsoil: The uppermost part of the soil, ordinarily moved in tillage, or its equivalent in uncultivated soils and ranging in depth from 6 to 18 inches. Frequently designated as the plow layer, the surface layer or the A horizon. Typically, has more organic matter and biologic activity than lower horizons of the soil profile.

1.5 QUALITY ASSURANCE

A. Analysis and Testing of Materials: For each type of packaged material required for the work of this Section, provide manufacturer's certified analysis. For all other materials, provide complete analysis by a recognized laboratory made in strict compliance with the standards and procedures of the following:

1. American Society of Testing Materials (ASTM)
2. American Society of Agronomy
3. Soil Science Society of America
4. Association of Official Agricultural Chemists.

B. Work and materials shall meet the standards of the following references:

1. International Society of Arboriculture
2. American Society for Testing Materials (ASTM)
3. Environmental Protection Agency (EPA)

C. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when soil is placed and landscape planting is in progress.

1. The Landscape Contractor shall have experience in the proper and safe transportation and installation of soil material.

2. The Landscape Contractor shall prepare and present to the Owner's representative required soil submittals and their associated specified test results one month prior to the scheduled soil and plant installation.

D. Soil Mixing Contractor Qualifications:

1. The Contractor shall have a minimum of 3 to 5 years experience preparing designed soil mixes.

2. Shall be able to provide soil mixes that meet the specifications within tolerances assigned.

3. Shall be able to produce enough consistently uniform soil material for the project to meet the scheduled demands.

E. Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

1. Employ a qualified independent testing and inspection laboratory acceptable to the Owner's representative and Owner to perform tests and certifications indicated.

2. It is the responsibility of Landscape Contractor in conjunction with the Soil Supplier to submit material for the soil and compost tests.

3. Tests shall be made in strict compliance with the standards of the Association of Official Analytical Chemists and follow standards from ASTM, EPA, and/or Methods of Soil Analysis, Soil Science Society of America.

1.6 SUBMITTALS

A. Certificates: Provide certificates required by authorities having jurisdiction, including any composted materials containing sewage sludge.

B. Tests of Organic Compost

C. Tests of the Mineral Aggregate component of Manufactured Soils

D. Test of final blended mixtures of Manufactured Soils

1. Include a written description of soil amendment rates that will be applied to each soil type, including calculated rates based on the test results for manufactured topsoils.

E. Tests of native topsoils: test a representative cross section of stripped native topsoils.

1. Test in order to determine amendment requirements to meet the parameters described in Part 2 of this specification.

2. Include a written description of soil amendment rates that will be applied to each soil type, including calculated rates based on the test results for native topsoils.

F. Tests of installed soils: Within one week of installation, perform one test for every 75x75 sf of area for each soil type. [A/E: These soil tests provide a baseline for ongoing monitoring of the site. Consult with Penn Project Manager, University Landscape Architect and Urban Parks in order to confirm full range of desired tests]



1. Include physical soil characteristic tests for soil texture (particle size), pH, bulk density, and organic matter
2. Included biological tests for Total/Active Bacteria, Total/Active Fungi, Protozoa, and Nematodes

3. Include a map identifying the location of each soil test performed

G. Sources for Soil Components and Planting Soil Mixes: Submit information identifying sources for all soil components and the contractor responsible for mixing of planting soil mixes.

H. Submit supplier name, contact person, address, telephone and fax number.

I. Submit certification that accepted supplier is able to provide sufficient quantities of materials and mixes for the entire project. Indicate quantity and type of material from each supplier.

J. Samples: Prior to ordering the listed materials, submit representative samples of the same organic batches and soil mixes that will be used to the Owner's representative for selection and approval. Do not order materials until the Owner's approval has been obtained. Delivered materials shall closely match the approved samples.

1. Organic Compost: duplicate samples of 1 quart.

2. Mineral aggregate: duplicate samples of 1 quart.

K. Soil Mix: duplicate samples of 1 quart for each soil layer after mixing organic material and mineral aggregate. The Soil Mix shall match the material being placed as closely as possible.

L. Manufacturer's information for all supplemental fertilization and amendments including but not limited to Lime, Sulphur, Nitrogen, Potassium, Phosphorous, and micronutrients.

1.7 DELIVERY, STORAGE AND HANDLING

A. Store and handle packaged materials in strict compliance with manufacturer's instructions and recommendations. Protect all materials from weather, damage, injury and theft.

B. Sequence deliveries to avoid delay. On-site storage space is permissible only with written notice from Owner. Deliver soil materials only after preparations for placement of planting soil have been completed.

C. Prohibit vehicular and pedestrian traffic on or around stockpiled soil.

D. Soil that is to be stockpiled longer than two weeks, whether on or off site, shall not be placed in mounds greater than six feet high.

E. Vehicular access to the site is restricted. Prior to construction the Contractor shall submit for approval a plan showing proposed routing for deliveries and site access which shall include, but not be limited to equipment movements and staging locations

F. Soil materials shall not be handled or hauled, placed or compacted when it is wet, as after a heavy rain, nor when frozen. Soil shall be handled only when the moisture content is less than 10 percent by volume. Soil materials shall be covered at least two weeks prior to installation to prevent excess moisture from saturating the soil stockpile.

G. Manufactured planting soil shall be mixed in a ball mill or tub mill fitted with proper screening and paddles, or other method ensuring a uniform mixing of the components.

1.8 ACCEPTANCE AND MAINTENANCE

A. Soil Installation Acceptance: Notify the Owner's representative at least 10 days in advance of date of soil placement. Inspection of the soil installation shall take place while the subgrade is visible and prior to placement of additional layers. Notify the Owner's representative 72 hours prior to inspection. Another inspection shall occur during the placement of the planting soil.

B. Partial Acceptance: Acceptance of partial areas or individual phases of the total work may be granted at the option of the Owner's representative.

C. Final Acceptance: Final acceptance shall be defined as the date after which the Owner's representative determine that all work, including Punch List items has been satisfactorily completed.

PART 2 – PRODUCTS

2.1 SOIL:

A. General: To the extent possible, on-site soils shall be retained and modified to meet the requirements of this specification. Native Topsoil is not to be removed from the site without the Owner's written permission. Manufactured soils are blended from Mineral Aggregate and Organic Compost meeting the parameters described in this section.

B. Soil types to be as follows: [A/E: adjust parameters below depending on ultimate species used in the project, or specify that the soil testing agency recommend amendments of N,P,K based on given species and soils tests]:

1. Native Lawn Soils [A/E: for use in low-profile lawn areas – determine applicability as part of the project]: Utilize topsoil stripped onsite and tested. Soils shall be amended at the time of installation to achieve the following parameters
   a. pH range of 6.0to 7.0. Soils indicated having a pH below 6.0 shall be treated with limestone as necessary to attain this pH range. Soils having a pH greater than 7.0 shall be treated with sulfur as necessary to attain this pH range.
   b. Percent Organic Matter: 3% - 8%
      Soils with OM below 3% shall be amended as follows:
      1) <2%: Add 3 cu yards of compost per 1000 sq feet
      2) 2.1%-3% Add 2 cu yards of compost per 1000 sq feet
   c. Starter Nitrogen (N): 1lb per 1000 sf
   d. Optimum Phosphorous (P): 75-110 ppm
      1) Soils below optimum range shall be amended with $P_20_5$ as required
   e. Optimum Potassium (K): 140-200 ppm.
      1) Soils below optimum range shall be amended with $K_20$ as required
   f. Micronutrients shall be tested for any required amendments based on soil test recommendations for lawn grass species

2. Manufactured Lawn Soils [A/E: for use in high-profile lawn areas – determine applicability as part of the project]: 10% Compost, 80% Sandy Loam by volume. Final, blended soil mix shall be tested. Soils shall be amended to achieve the following parameters:
   a. pH range of 6.0 to 7.0. Soils indicated having a pH below 6.0 shall be treated with limestone as necessary to attain this pH range. Soils having a pH greater than 7.0 shall be treated with sulfur as necessary to attain this pH range.
   b. Starter Nitrogen (N): 1 lb per 1000 sf
   c. Optimum Phosphorous (P): 75-110 ppm
      1) Soils below optimum range shall be amended with $P_20_5$ as required
   d. Optimum Potassium (K): 140-200 ppm.
      1) Soils below optimum range shall be amended with $K_20$ as required
   e. Micronutrients shall be tested for any required amendments based on soil test recommendations for lawn grass species

3. Native Planting Soils: Utilize topsoil stripped onsite and tested. If necessary, soils shall be amended at the time of installation to achieve the following parameters:
   a. pH range of 5.5 to 7.0. Soils indicated having a pH below 5.5 shall be treated with limestone as necessary to attain this pH range. Soils having a pH greater than 7.0 shall be treated with sulfur as necessary to attain this pH range.
   b. Percent Organic Matter: 3% - 8% Soils with OM below 3% shall be amended as follows:
      1) <2%: Add 3 cu yards of compost per 1000 sq feet
      2) 2.1%-3% Add 2 cu yards of compost per 1000 sq feet
   c. Micronutrients shall be tested for any required amendments based on soil test recommendations for acid loving ornamental species

4. Manufactured Planting Soils [A/E: for use in areas where native soils are not available due to limited availability of topsoil. Manufactured Soils and Native Topsoils should NOT be blended together]: 10% Compost, 80% Sandy Loam by volume. Final, blended soil mix shall be tested. If necessary, soils shall be amended at the time of installation to meet the following parameters:
   a. pH range of 5.5 to 7.0. Soils indicated having a pH below 5.5 shall be treated with limestone as necessary to attain this pH range. Soils having a pH greater than 7.0 shall be treated with sulfur as necessary to attain this pH range.
   b. Micronutrients shall be tested for any required amendments based on soil test recommendations for acid loving ornamental species

5. Bioretention Soils: An initial mix of 20% Bioretention Topsoil to 80% Mineral Aggregate by weight to create a Preliminary Mix. Then combine 25% Compost to 75% Preliminary Mix by volume. Final mix shall be tested. If necessary, soils shall be amended at the time of installation to meet the following parameters:
   a. pH range of 5.5 to 7.0. Soils indicated having a pH below 5.5 shall be treated with limestone as necessary to attain this pH range. Soils having a pH greater than 7.0 shall be treated with sulfur as necessary to attain this pH range.
   b. Micronutrients shall be tested for any required amendments based on soil test recommendations for acid loving ornamental species

B. The Sandy Loam portion of shall be produced from a Blend of Mineral Aggregate and a Loam Topsoil to achieve the following parameters:
   6. pH: 5.5-6.5
   7. EC: 1.5 dS/m
   8. Particle Size Distribution:

| Sieve Size | Percent Passing |
|---|---|
| 3/8 inch | 100 |
| No. 10 | 95 - 100 |
| No.18 | 90-100 |
| No. 35 | 65-85 |
| No. 60 | 30-40 |
| No. 140 | 15-25 |
| No. 270 | 9-18 |
| silt | 6-12 |
| clay | 3-6 |

C. The Mineral Aggregate Component of manufactured soils (also the drainage layer) shall be natural sand or finely ground recycled glass meeting the following parameters:
   1. pH: 4.5-7.0
   2. Organic Matter <0.25%
   3. Particle Size Distribution:

| Sieve Size | Percent Passing |
|---|---|
| 3/8 inch | 100 |
| No. 10 | 95 - 100 |
| No.18 | 80-95 |
| No. 35 | 60-80 |
| No. 60 | 10-40 |
| No. 140 | 8-15 |
| No. 270 | 1-10 |
| silt | 1-6 |
| clay | 0-4 |



D. The Compost Component of manufactured soils and native soil amendments shall be a well decomposed, stable, weed free organic matter source. It shall be derived from: agricultural, food, or industrial residuals, treated biosolids, yard trimmings, source-separated or mixed solid waste. Compost will possess no objectionable odors and shall not resemble the raw material from which it was derived. Compost shall meet the following parameters:

| **Criteria** | **Units of Measure** | **Acceptable Range** |
|---|---|---|
| Carbon/Nitrogen Ratio | - | 10-20 |
| Degree of Maturity | $CO_2$-C/g organic matter/day | <2 mg |
| Organic Matter % | (Dry Wt.) | 50 – 60% |
| pH | - | 5.5-8.0 |
| Nitrogen (N) | (Dry wt.) | 0.5-2.5% |
| Maturity: Seed Emergence | % of Control | Min. 80% |
| Maturity: Seed Vigor | % of Control | Min. 80% |
| Particle Size | % Passing ¾" Screen | 98% |
| Soluble Salt Concentration (electrical conductivity) | dS/m (mmmhos/cm) | <10 |
| Solids content | % at 50-40% moisture | 50-60% |
| Heavy Metals and Fecal Coliform | | Meet or Exceed US EPA Class A Standard, 40 CFR Sect. 503.32(a) levels |

E. The Bio-filtration Topsoil Component of Bioretention Soils may be imported or soils stripped on site (preferred) provided they meet the following parameters:

| **Criteria** | **Units of Measure** | **Acceptable Range** |
|---|---|---|
| Organic Matter | (Dry wt) | 2-5% |
| pH | - | 5.5-6.5 |
| Phosphorous (P) | ppm | 20-40 |
| Potassium (K) | ppm | 200-600 ppm |
| Cation Exchange Capacity | Meq/100g | > 10 |
| **Particle Size** | **Passing Sieve** | **Percent Passing** |
| Gravel | 4 | 100 |
| Fine Gravel | 10 | 95-100 |
| Sand | 60 | <40 |
| Silt + Clay | 270 | <25 |
| Clay | - | <5 |

F. Lime: ASTM C 602, Class T or O, agricultural limestone containing not less than 85% of total carbonates and shall be ground to such fineness that 50% will pass through a 100-mesh sieve and 90% will pass through a 200-mesh sieve.
G. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through No. 6 sieve and a maximum 10 percent passing through No. 40 sieve.
H. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
I. Supplemental Fertilizers: consisting of non-synthetic ingredients such as Blood Meal, Rock phosphate, Soybean meal, Greensand, Kelp meal, or similar ingredients. To be approved per submittal requirements, above.

PART 3 - EXECUTION

3.1 COORDINATION

A. Pre-Installation Examination Required: The Contractor shall examine previous work, related work, and conditions under which this work is to be performed and shall notify the Owner in writing of all deficiencies and conditions detrimental to the proper completion of this work. Beginning work means the Contractor accepts substrates, previous work, and conditions. The Contractor shall not place any planting soil until all work in adjacent areas is complete and approved by the Owner.

B. Coordinate activities with other project contractors so that there is no soil disturbance from vehicle or foot traffic or other construction activities after placement.

3.2 PREPARATION OF SOILS PRIOR TO PLACEMENT

A. Manufactured soil shall be mixed in a ball mill or tub mill fitted with proper screening and paddles. Windrowing the materials is not acceptable, as it does not produce uniform mixing of the components.

B. Mixing of the compost for the soils shall be accomplished in the same manner as the other mixing procedures. The compost shall have a consistent moisture content between 30 and 50% at the time of mixing.

C. Examine native soils and remove any foreign materials, stones over 1", and organic debris over 2" in length.

3.3 PREPARATION OF SUBGRADE

A. Decompaction of subsoil: Subsoil under planting and lawn soils shall be decompacted immediately before placement of topsoils. [A/E: confirm that Decompaction of subsoils is feasible given the constraints of the project. Consider the number of subsurface obstacles and concerns regarding infiltration and groundwater pollution]

1. Clearly mark locations of all underground utilities, irrigation lines, tree roots or other obstructions to be avoided prior to the beginning of Decompaction



2. Decompaction shall not occur when subsoil is wet. Samples taken from a depth of 18" shall be optimum moisture at the time of Decompaction.
3. Subsoils shall be fractured or ripped to a depth of 18 inches
4. Fracturing or Ripping shall provide continuous breaks in the subsoil no further than 48" apart. Ripping shall occur in two passes at 45 degree angles to one another. In linear areas too narrow to achieve a 45 degree pass, the second pass shall be performed in an S curve.

B. Bioretention Soils: Excavation for bioretention areas shall not occur until immediately before placement of bioretention soils in order to prevent silting of subsoils.

1. Excavation of the soils shall be accomplished to depths noted for each soil profile area. All construction debris shall be removed from the planting areas prior to placement of the soil layers. Care shall be taken to avoid working the soil when it has 10 percent moisture content or above.
2. Bio-retention areas shall be excavated to elevations shown on the drawings. All bed bottoms are level unless indicated otherwise on plans.
3. Scarification of the Subgrade: After excavation of the subgrade is accomplished, scarification must loosen the compacted surface of the subgrade following final rough grade to a depth of 4 inches prior to soil placement.
4. Soil placement (below) shall occur immediately after the excavation of bioretention areas.
5. Erosion Control Protection Measures shall be put in place immediately after placement of bioretention soils.

3.4 PLACEMENT OF SOILS

A. Place the soil types according to drawings.
1. Soil installation shall be in lifts not exceeding 6 inches in depth
2. Scarify each layer of soil between lifts using methods that minimize compaction of soils

B. Soil Depths shall be as follows, unless otherwise indicated on drawings [A/E: confirm the following depths and modify based on project parameters]:
1. Native Lawn Topsoil: 6" Minimum Depth
2. Native Planting Topsoil: 12" Minimum Topsoil Depth
3. Manufactured Lawn Layers (unless otherwise indicated on drawings)
   a. 6" Depth of Manufactured Lawn Topsoil (at surface)
   b. 6" Depth of Sandy Loam (Subsurface)
   c. 6" Depth of Mineral Aggregate (Drainage Layer)
   d. Scarified subsoil
4. Bioretention Layers:
   a. 10" Depth of Bioretention Soils
   b. 24" Depth of Mineral Aggregate (Drainage Layer)

C. Soil amendments addressing pH and supplemental organic matter shall be tilled into the top 4" of soils as required by the parameters outlined in Part 2 of this specification.

D. Rake, finish grade, and apply any necessary starter fertilization immediately prior to seeding or planting, per Planting or Turf specifications.

3.5 PROTECTION AND REPAIRS

A. Protect all planting soils from vehicle and foot traffic. Keep free of trash, debris or construction materials.
   a. Utilize protection fencing to protect newly installed soils and newly planted areas from unauthorized foot traffic.
   b. Materials shall be consistent with those specified in 32 01 90 - TREE AND PLANT PROTECTION

B. Within the installation warranty period repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or compacted due to subsequent construction operations or weather conditions.

   1. Scarify or remove and replace material to a depth as directed by the Owner; reshape and re-compact by only hand tamping at the prescribed moisture content.

END OF SECTION 32 91 00

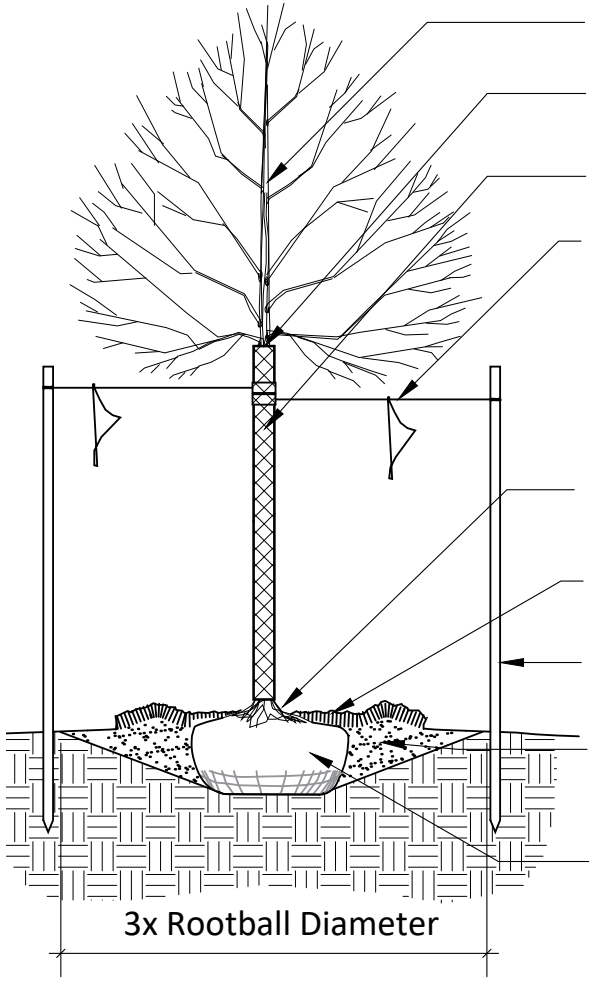
# Appendix D

## *SUPPLEMENTAL DETAILS*

Penn's library of standard details includes a range of paving types but is very limited in standard planting details. Recommended standard details for deciduous trees, evergreen trees, shrubs, and plugs are included here. These standards can help ensure that plants are planted properly, with their root collars exposed, adequate room for roots, and with an appropriate amount of mulch.

Supplemental details for porous asphalt and permeable pavers are also included within this appendix. Permeable paving improves stormwater quality and improves groundwater levels, making it available for adjacent vegetation. Porous asphalt could be utilized in utilitarian spaces such as service drives or parking areas. Permeable pavers can take the form of brick, cobble, or precast concrete, and are suitable for higher profile pedestrian locations.

As Penn's detail library evolves in the future, the University should further consider standard materials selections that maximize recycled content, reduce urban heat-island effect (SRI), and minimize life-cycle carbon footprint.




PRUNE ONLY BROKEN OR DEAD BRANCHES.

REMOVE TRANSIT TRUNK GUARDS IMMEDIATELY AFTER PLANTING.

TRUNK SHALL BE PLUMB

TWO (2) GALVANIZED, TWISTED, 14 GAUGE WIRES AT 180° AROUND TREE. ATTACH TO TREE USING POLYPROPYLENE STRAPS. FLAG OR TAPE EACH STRAP USING BRIGHT-COLORED MATERIAL. TENSION OF WIRES NOT TAUT TO ALLOW FOR SMALL AMOUNT OF TRUNK MOVEMENT. REMOVE AFTER ONE (1) YEAR.
- FOR MULTISTEMMED TREES, SECURE THREE (3) MAIN STEMS WITH ONE (1) WIRE AND ONE (1) POLYPROPYLENE STRAP EACH.

ROOT COLLAR SHALL BE 1" TO 2"+/- HIGHER THAN THE ADJACENT FINISH GRADE; TRUNK FLARE MUST BE EXCAVATED PRIOR TO PLANTING.

ONE INCH (1") OF HARDWOOD BARK MULCH OR APPROVED EQUAL. MULCH TO WITHIN SIX INCHES (6") OF TRUNK / COLLAR

4' X 2" X 2" HARDWOOD STAKE 120° APART, DRIVEN FLUSH TO FINISH GRADE. THREE (3) PER TREE. STREET TREES TO RECEIVE TWO (2) PER TREE, POSITIONED TOWARD ROAD

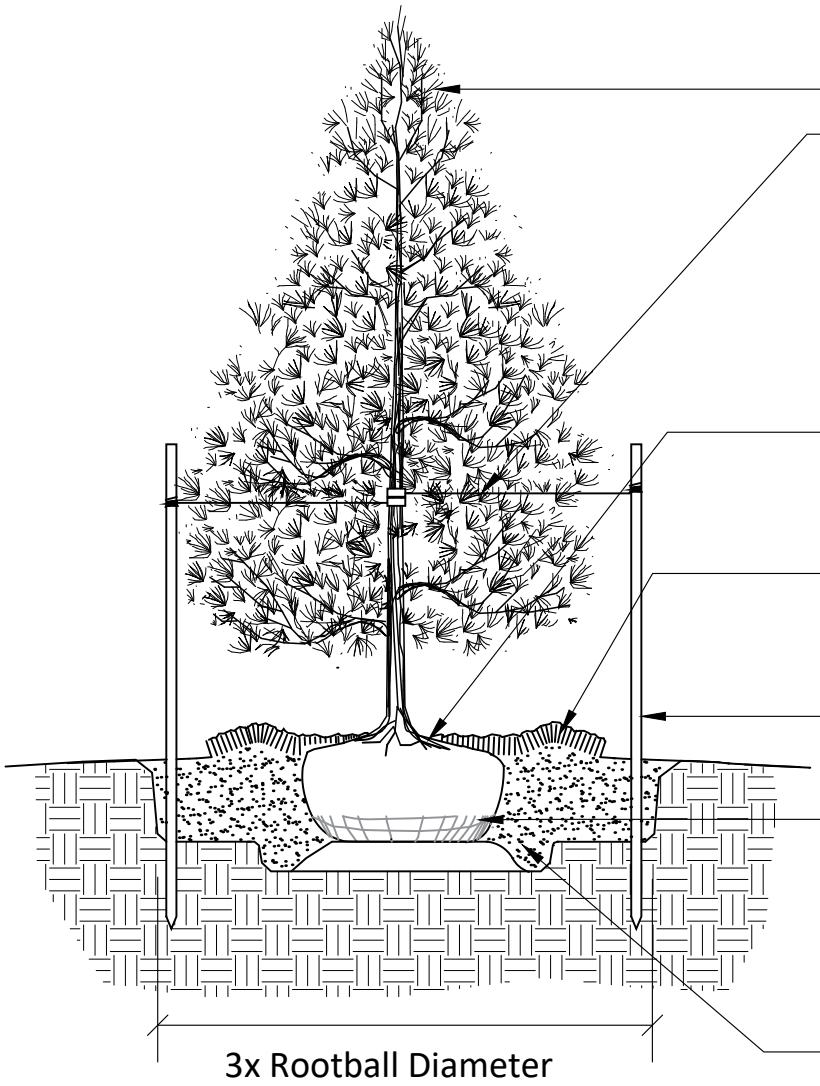
BACK FILL USING EXCAVATED TOPSOIL, OR SPECIFIED SOIL MIX.
WATER THOROUGHLY TO ELIMINATE AIR POCKETS. DO NOT COMPACT.
LOOSEN SIDE OF PLANTING HOLE AS PER ANSI Z60.1 STANDARD.

REMOVE ALL TWINE, WIRE, ROPE AND BURLAP FROM THE TOP $\frac{3}{4}$ OF ROOT BALL. REMOVE ALL NON-ORGANIC MATERIAL FROM ENTIRE ROOT BALL. FOR WIRE BASKETS, CUT AND SPREAD BOTTOM PRIOR TO PLACING TREE IN HOLE. CUT AWAY AND REMOVE REMAINDER OF WIRE.

NOTE: Nylon or Treated Burlap is unacceptable

# DECIDUOUS TREE PLANTING

NTS




APPLY ANTI-DESICCANT FOR FALL PLANTINGS.

PRUNE ONLY BROKEN OR DEAD BRANCHES

THREE (3) GALVANIZED, TWISTED, 14 GAUGE WIRES AT 120° AROUND TREE. ATTACH TO TREE USING POLYPROPYLENE STRAPS. TENSION OF WIRES NOT TAUT TO ALLOW FOR SMALL AMOUNT OF TRUNK MOVEMENT. REMOVE AFTER ONE (1) YEAR.

ROOT COLLAR SHALL BE 2" HIGHER THAN THE ADJACENT FINISH GRADE. REMOVE EXCESS SOIL FROM TOP OF ROOT BALL.

ONE INCH (1") OF HARDWOOD BARK MULCH OR APPROVED EQUAL. MULCH TO WITHIN SIX INCHES (6") OF TRUNK / COLLAR.

4' X 2" X 2" HARDWOOD STAKE 180° APART, DRIVEN FLUSH TO FINISH GRADE. TWO (2) PER TREE.

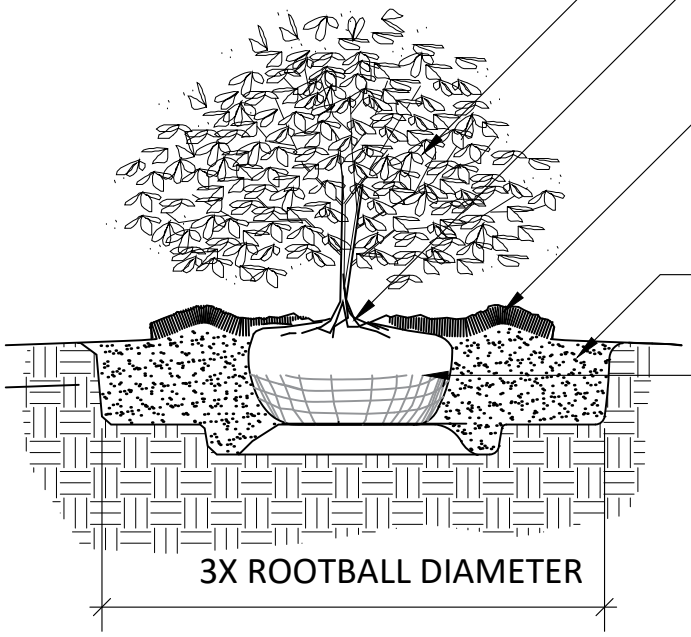
REMOVE ALL TWINE, WIRE, ROPE, AND BURLAP FROM THE TOP $\frac{3}{4}$ OF ROOT BALL. ALL NON-ORGANIC MATERIAL FROM ENTIRE BALL. FOR WIRE BASKETS, CUT TOP AND FOLD DOWN IN THE PIT AFTER POSITIONED AND READY FOR BACKFILL.

BACKFILL USING SPECIFIED SOIL MIX. WATER THOROUGHLY TO ELIMINATE AIR POCKETS. DO NOT COMPACT.

NOTE: Nylon or Treated Burlap is unacceptable

# EVERGREEN TREE PLANTING

NTS




FOR EVERGREEN SHRUBS APPLY ANTI-DESICCANT TO ENTIRE PLANT AT RECOMMENDED RATES AND TIMES.

PRUNE ONLY BROKEN OR DEAD BRANCHES.

ROOT COLLAR SHALL BE 2" HIGHER THAN THE ADJACENT FINISH GRADE. REMOVE EXCESS SOIL FROM TOP OF ROOT BALL.

ONE INCH (1") OF HARDWOOD BARK MULCH OR APPROVED EQUAL. DO NOT MOUND MULCH AGAINST SHRUB. MULCH TO BE CONTINUOUS IN BED AREAS.

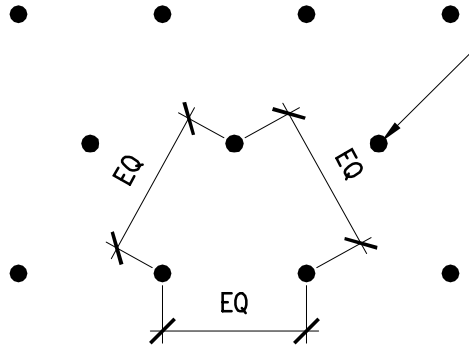
BACKFILL USING SPECIFIED SOIL MIX. WATER THOROUGHLY TO ELIMINATE AIR POCKETS.

BALL AND BURLAPPED SHRUBS - REMOVE ALL TWINE, WIRE, ROPE, AND BURLAP FROM THE TOP $\frac{1}{3}$ OF ROOT BALL. REMOVE ALL NON-ORGANIC MATERIAL FROM ENTIRE BALL. CONTAINER SHRUBS - REMOVE CONTAINER COMPLETELY. MAKE 3 TO 4 CUTS THE LENGTH OF THE ROOT BALL. LOOSEN ROOTS AND SPREAD OVER COMPACTED TOPSOIL.

NOTE: Nylon or Treated Burlap is unacceptable

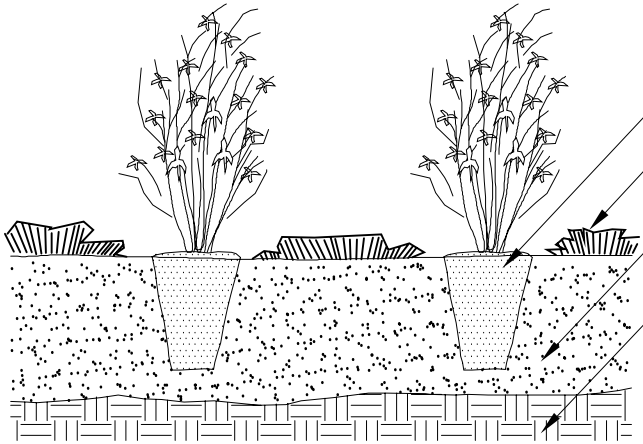
# SHRUB PLANTING - EVERGREEN AND DECIDUOUS

NTS




PLUG OR CONTAINER PLANT
SEE SCHEDULE FOR SPACING

PLAN



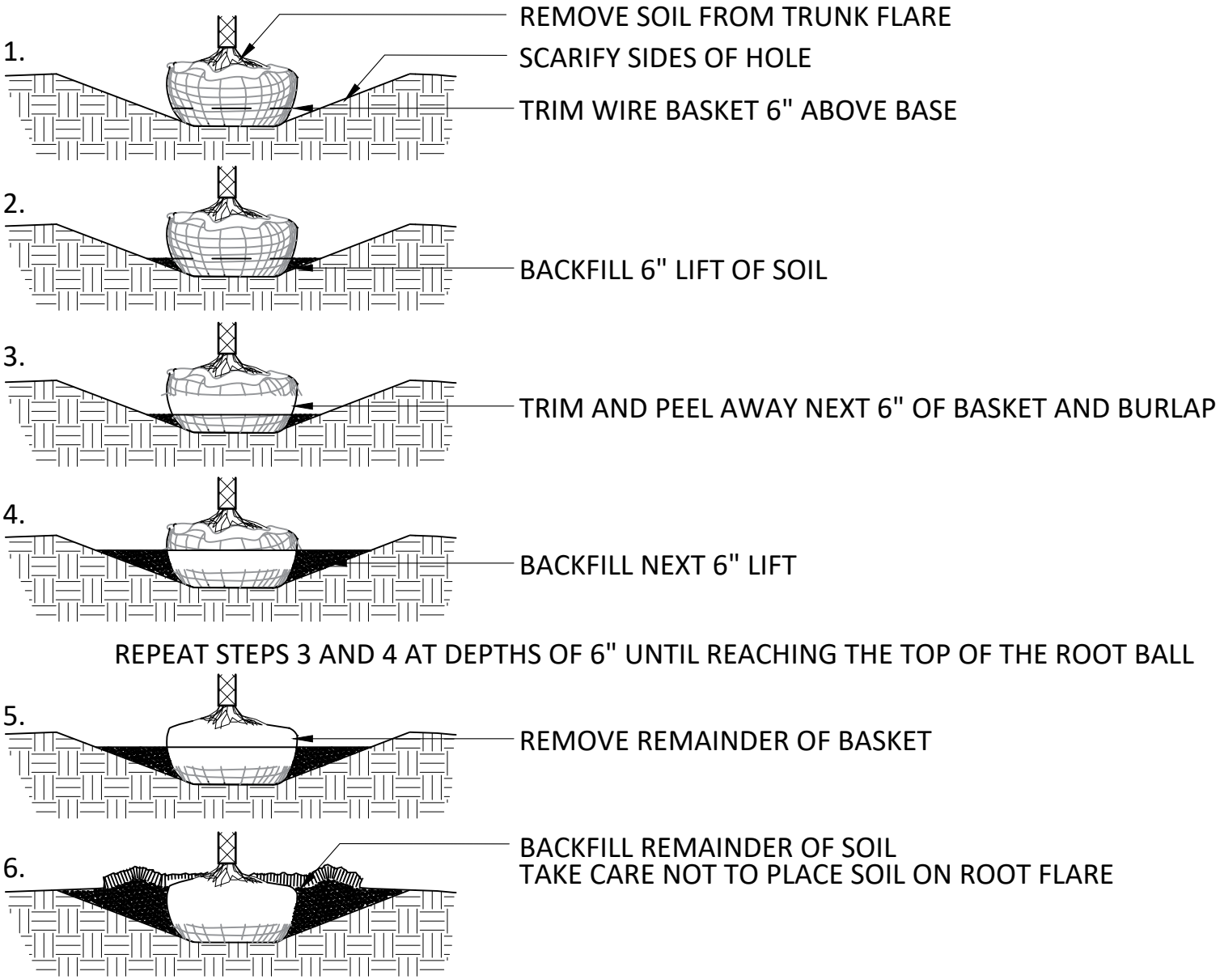
PLUG OR CONTAINER PLANT
MULCH: ONE INCH DEPTH. DO NOT ALLOW MULCH TO TOUCH BASE OF PLANT
TOPSOIL
UNCOMPACTED SUBGRADE

NOTES:

1. DIP ROOTS INTO WATER ABSORBANT GEL IMMEDIATELY BEFORE PLANTING
2. SEPERATE AND SPREAD OUT ANY POT-BOUND ROOTS

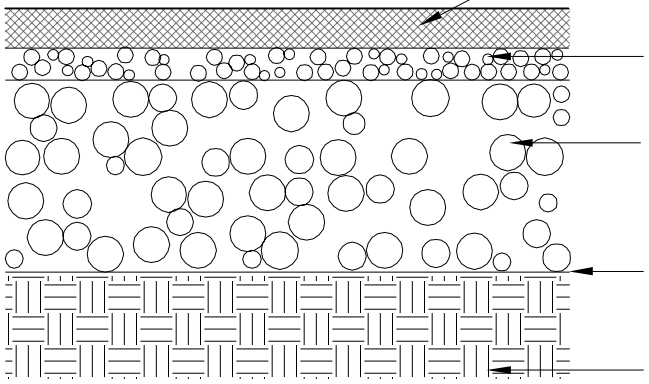
## PLUG AND CONTAINER PLANTING

NTS



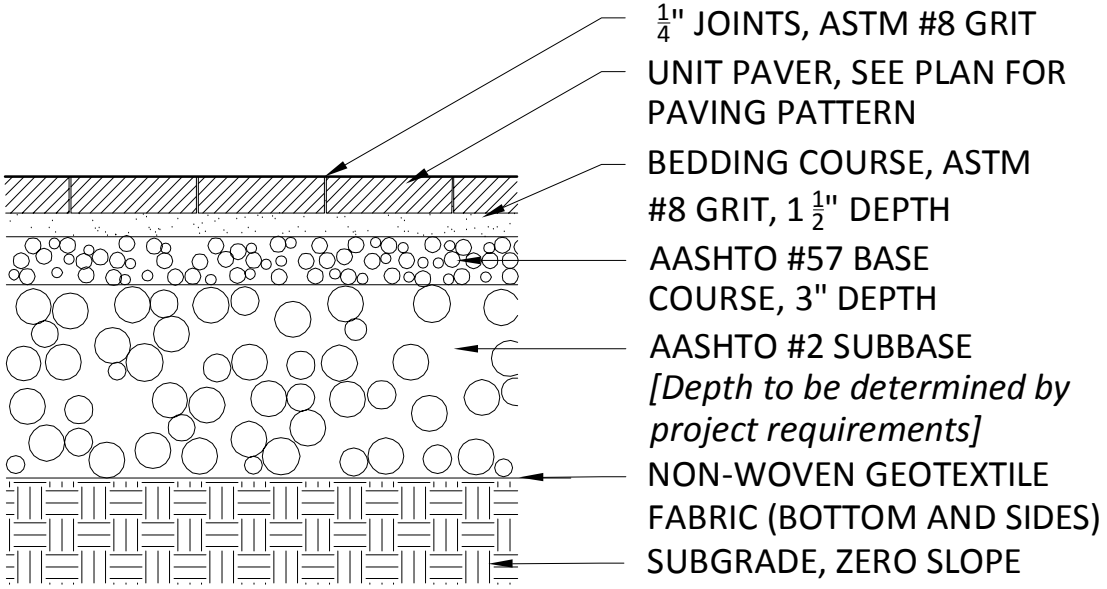

# BALL AND BURLAP PREPARATION AND REMOVAL DURING PLANTING

NTS




# POROUS ASPHALT PAVING

Scale: 1" = 1'-0"




# PERMEABLE PAVERS

Scale: 1" = 1'-0"

# Appendix E

## *PLANT HEALTH CARE PROGRAM*

Plant health care programs incorporate the concepts of Integrated Pest Management (IPM) into a strategic land management strategy. The Environmental Protection Agency outlines a solid base for IPM in school settings. IPM strategies emphasize prevention first: utilizing good cultural practices to prevent disease in the first place. Where prevention is not enough, mechanical controls are the first line of defense, followed by chemical controls as a last resort.

For a plant health care program to be effective, a knowledgeable horticulturist must be accountable for the ongoing monitoring and reporting of plant health across campus. Ultimately, it is recommended that “Skilled Gardeners” gain the training required to execute this program. Until that position is in place, plant health care should be performed by a certified arborist or a similarly trained horticulturist.

Sensing equipment, such as that utilized at Shoemaker Green, can enhance the Skilled Gardeners' monitoring abilities. Dialogue with Villanova, University of Maryland, and other schools utilizing such equipment is recommended as Penn expands its own sensing capabilities.

The following is a simplified plant health care schedule for regular ongoing evaluation of plant health throughout campus, as well as checklists for regular evaluation of incoming nursery stock and existing trees. In the future, a more robust and comprehensive document containing specific species of concern should be developed. For that document, focus should be placed on observation, plant health, and cultural practices. Chemical interventions should only be considered as a worst case scenario.

University of Pennsylvania ELSP
February 2018

Landscape Maintenance Schedule

| | | Early Spring | Late Spring | Early Summer | Late Summer | Fall | Winter |
|---|---|---|---|---|---|---|---|
| **Trees, Shrubs, Evergreens** | **Pruning** | Monitor for hazardous branches. | Prune early spring-blooming shrubs and trees after blooming to remove all dead/hazardous material and crossing branches. | Monitor for hazardous branches. | Prune later-blooming trees and shrubs as needed prior to mid - September. | Monitor for hazardous branches. | Prune dead/crossing branches and evaluate tree shape and canopy height. |
| | **Weeding** | Monitor for invasive weeds and remove. | Monitor for invasive weeds and remove. | Weed mulch rings twice monthly. Weed seedlings in planting beds. | Weed mulch rings twice monthly. Weed seedlings in planting beds. | Monitor for invasive weeds and remove. | |
| | **Watering** | | If it is a dry spring, water 1" per week | | Monitor for drought stress and water 1" per week as required. | Monitor for drought stress and water 1" per week as required. | Water evergreens thoroughly during any warm dry spells. |
| | **Soil/Mulch** | Renew Compost and Mulch. Mulch shall not exceed 1" depth. Mulch shall be placed 6"-12" away from tree trunk. | Fertilize with compost tea | Fertilize spring blooming plants with compost tea after bloom | | | |
| | **Cleanup** | | Cleanup spent flowers from spring blooming species. | Cleanup seed pods and tree litter as needed. | Cleanup seed pods and tree litter as needed. | Leaf Cleanup: In designated areas, allow leaves to lay or shred leaves in place. In areas where removal is required, take care not to damage perennial layers with blowers or other equipment. | Remove heavy snow from branches of evergreens to prevent breakage. |
| | **Disease Control** | Control known problem plants with biological fungicide as buds break. | Monitor for black spot and treat with biological fungicide as required. Inspect for Cankers and Blights, and remove infected branches. | Inspect for cankers and blights, and remove infected branches. | Monitor for leaf spots and other foliar diseases, remove diseased foliage as it falls to prevent spread. Monitor for powdery mildew. | Spray Anti-desiccant on broad leaf evergreens when temperatures are above 40 degrees F. | Apply dormant miscible oil spray to trees and shrubs as needed for insect control in February. |

Note: Weed removal methods depend on the species being removed and time of year. In general, minimize ground disturbance as much as possible when removing weeds. Weeds with deep taproots and stoloniferous systems require aggressive removal over multiple seasons, while weeds with less extensive root systems can be eradicated more quickly and with less disturbance. The National Park Service has detailed recommendations for removal by species: www.nps.gov/plants/alien

University of Pennsylvania ELSP
May, 2017

Landscape Maintenance Schedule

| | | Early Spring | Late Spring | Early Summer | Late Summer | Fall | Winter |
|---|---|---|---|---|---|---|---|
| **Perennials and Grasses** | **Watering** | | If it is a dry spring, water 1" per week. Monitor new plantings twice weekly and water as required. | Monitor for drought stress and water if necessary. | Monitor for drought stress and water if necessary. | Monitor for drought stress and water if necessary. Monitor new plantings twice weekly and water as required. | |
| | **Soil/Mulch** | Mulch beds with shredded hardwood mulch, 1" max depth. Plant communities featuring dense, ground covering and spreading perennials shall not be mulched. | Plant communities with high nutrient requirements should be fertilized with compost tea. Low-fertility native plant communities should not be fertilized. | | | | |
| | **Planting** | Monitor perennials for signs of winter rot and rodent damage, replace plants that are poorly suited to conditions or uniquely prone to rodent damage. Plant supplemental container perennials. | Plant supplemental container perennials. | Evaluate plantings on campus and identify any species that are improperly sited. Plan for fall transplants of any poorly sited species to more suitable locations. | Evaluate perennial beds for gaps, aesthetics, and biodiversity. Identify areas for supplemental planting. Quantify and order plants for the coming fall and following spring. | Plant supplemental container perennials, plugs and bulbs. Apply bone meal or Bulb Tone with Bulbs. | Order replacement plants for the coming year. Evaluate plant quality from previous year and adjust list of preferred suppliers as necessary. |
| | **Disease Control** | . | Monitor perennials for early signs of fungal infections such as rusts or spots, apply Neem Oil or other biological fungicide if required. | Monitor for signs of diseases and investigate disease source: pests, diseases carried by new plants, cultural stress, other? | Monitor for signs of powdery mildew and other foliar diseases, apply biological fungicides early and remove infected foliage as required. | Cut back and dispose of any diseased foliage - do not incorporate diseased foliage into compost. | |
| | **Division/Pruning** | Cut Back Perennials and Grasses and Divide Summer/Fall Blooming Perennials | Allow foliage on later blooming bulbs to develop after blooms fade. Cut back foliage once tips begin to turn brown. | Divide spring blooming perennials, remove flowers as they fade. | | | |
| | **Weeding** | Apply corn gluten pre-emergent. Timing is critical: apply corn gluten as Forsythia begins to bloom. | Weed beds once a week. | Weed beds once a week. Cut back flowers on weeds before they generate seedheads. | Weed beds once a week. Cut back flowers on weeds before they generate seedheads. | Weed beds once a week. Cut back flowers on weeds before they generate seedheads. | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Annuals** | Plant Cool Season Annuals | Plant Tender Annuals | water 1" per week | water 1" per week | water 1" per week | |
| | Replenish Soils in Containers | | Weed beds once a week | Weed beds once a week | Weed beds once a week | |

University of Pennsylvania ELSP
May, 2017

Landscape Maintenance Schedule

| | | Early Spring | Late Spring | Early Summer | Late Summer | Fall | Winter |
|---|---|---|---|---|---|---|---|
| **Lawn** | **Mowing** | Mow if necessary to keep grass 3"-4" in height. | Maintain grass areas by mowing on an as-needed basis to keep grass 3"-4" in height. Minor bulbs such as crocus that bloom prior to initial lawn cutting can be cut down at the time of the initial lawn cutting. Allow foliage on later blooming bulbs to develop after blooms fade. | Maintain grass areas by mowing on an as-needed basis to keep grass 3"-4" in height. | Maintain grass areas by mowing on an as-needed basis to keep grass 3"-4" in height. | Maintain grass areas by mowing on an as-needed basis to keep grass 3"-4" in height. | Mow if necessary to keep grass 3"-4" in height. |
| | **Watering** | | Monitor moisture and irrigation levels. Adjust irrigation as required to maintain 1" per week. | Monitor moisture and irrigation levels. Watch for signs of fungal disease as a result of too much water, or drought stress as a result of too little. Fine tune irrigation levels accordingly. | Monitor moisture and irrigation levels. Watch for signs of fungal disease as a result of too much water, or drought stress as a result of too little. Fine tune irrigation levels accordingly. | Monitor moisture and irrigation levels. Watch for signs of fungal disease as a result of too much water, or drought stress as a result of too little. Fine tune irrigation levels accordingly. | Winterize irrigation system before the first frost. |
| | **Soil Amendment** | Rake thoroughly and remove thatch. If the lawn area requires rejuvenation, apply lime and compost tea as prescribed per soil analysis. | Additional compost tea may be applied 2 to 3 weeks after Weed Ban's application. Topdress with compost. | | Perform soil analysis | Core aerate and topdress with compost. Apply lime, fertilizer as recommended by soil analysis. | Perform soil analysis. |
| | **Weed Control** | | Apply "Weed BAN"- or equal-organic corn gluten meal pre-emergent around mid-March, (when Forsythia starts to bloom). | | Solarize areas dominated by weed species for reseeding in fall. | | |
| | **Seeding** | Overseed bare patches with sun, shade or combination seed mix, as appropriate. | | | | Overseed bare patches with sun, shade or combination seed mix, as appropriate. | |
| | **Protection** | | Protect overseeded areas from use for one month. Rest lawns for 48 hours after heavy usage. | | | Rest lawns for 48 hours after heavy usage. | Protect overseeded areas from use for one month. |

University of Pennsylvania ELSP
May, 2017

Landscape Maintenance Schedule

| | Early Spring | Late Spring | Early Summer | Late Summer | Fall | Winter |
|---|---|---|---|---|---|---|
| **Meadows** | | | | | | |
| **First Year Seeded Meadows** | Mow vegetation to a height of 8" with a flail type mower whenever the meadow reaches a height of 18-20". Clippings should be collected and composted. | Mow vegetation to a height of 8" with a flail type mower whenever the meadow reaches a height of 18-20". Clippings should be collected and composted. | Mow vegetation to a height of 8" with a flail type mower whenever the meadow reaches a height of 18-20". Clippings should be collected and composted. | Mow vegetation to a height of 8" with a flail type mower whenever the meadow reaches a height of 18-20". Clippings should be collected and composted. | Mow vegetation to a height of 8" with a flail type mower whenever the meadow reaches a height of 18-20". Clippings should be collected and composted. | Let meadow stand throughout the winter to encourage wildlife. |
| | | | | | | |
| **Second Year Seeded Meadows** | Mow meadow to a height of 4" in early-to-mid- March to prevent intrusion by invasive vegetation. Clippings should be collected and composted. | When weeds are in bloom, mow with a flail-type mower or string trimmer to a height of 12". Clippings should be collected and composted. | When weeds are in bloom, mow with a flail-type mower or string trimmer to a height of 12". Clippings should be collected and composted. | When weeds are in bloom, mow with a flail-type mower or string trimmer to a height of 12". Clippings should be collected and composted. | When weeds are in bloom, mow with a flail-type mower or string trimmer to a height of 12". Clippings should be collected and composted. | Let meadow stand throughout the winter to encourage wildlife. |
| | | | | | | |
| **Established Meadows (Seed Meadows after Year Three)** | If desired, augment existing meadow with species appropriate to site conditions through over-seeding or installation of plugs. | Monitor meadow for intrusion of invasive plants. Use spot applications of herbicide to control invasive species, or remove by hand. Remove any seed heads before they have a chance to develop. | Monitor meadow for intrusion of invasive plants. Use spot applications of herbicide to control invasive species, or remove by hand. Remove any seed heads before they have a chance to develop. | Monitor meadow for intrusion of invasive plants. Use spot applications of herbicide to control invasive species, or remove by hand. Remove any seed heads before they have a chance to develop. | Let meadow stand throughout the fall to encourage wildlife. | Let meadow stand throughout the winter to encourage wildlife. |
| | Mow meadow to a height of 6" in early-to-mid- March to prevent intrusion by invasive vegetation. Clippings should be collected and composted. | Established Meadows **should not be mowed between April 1 and July 15th,** when wildlife may be nesting | Established Meadows **should not be mowed between April 1 and July 15th,** when wildlife may be nesting | **Optional:** Mow to a height of 6" between July 15th and August 1st to encourage Warm Season Grasses. | | |

University of Pennsylvania ELSP
May, 2017

Landscape Maintenance Schedule

| | | Early Spring | Late Spring | Early Summer | Late Summer | Fall | Winter |
|---|---|---|---|---|---|---|---|
| **Trees, Shrubs, Perennials and Grasses: First year after installation.** | **Watering** | Hand water individual species weekly | Hand water individual species weekly, more often in unseasonably hot and dry weather. | Hand water individual species twice weekly | Hand water individual species weekly | Hand water individual species weekly, more often in unseasonably hot and dry weather. | Hand water evergreens during any warm, dry periods. |
| | **Soil/Mulch** | Mulch beds with shredded hardwood mulch, 1" max depth. | | | | | |
| | **Disease Control** | Monitor for signs of diseases and investigate disease source. If disease appears to have been brought in by nursery, remove and replace plants from reputable supplier. | Monitor perennials for early signs of fungal infections such as rusts or spots, apply Neem Oil or other biological fungicide if required. | Monitor for signs of diseases and investigate disease source. If disease appears to have been brought in from nursery, remove and replace plants from reputable supplier. | Monitor for signs of powdery mildew and other foliar diseases, apply biological fungicides early and remove infected foliage as required. | Cut back and dispose of any diseased foliage - do not incorporate diseased foliage into compost. | Apply anti-desiccant to evergreen shrubs and trees to prevent winter burn. |
| | **Physical Controls** | Monitor trees for wind damage - stake trees if necessary to prevent tilting in high wind locations. | Monitor trees and shrubs for settling. If Rootballs settle such that root collar is no longer 2" above adjacent grade, bring up rootball and reset. | | Monitor trees and shrubs for settling. If Rootballs settle such that root collar is no longer 2" above adjacent grade, bring up rootball and reset. | | Monitor trees for signs of damage from animals - apply protection measures as necessary. Examine trees and remove any tags or markers left on from the nursery. |
| | **Weeding** | Weed beds once a week. | Weed beds once a week. | Weed beds once a week. Cut back flowers on weeds before they generate seedheads. | Weed beds once a week. Cut back flowers on weeds before they generate seedheads. | Weed beds once a week. Cut back flowers on weeds before they generate seedheads. | |

**INSPECTION OF INCOMING NURSERY STOCK**

**Root Collar:**
- Root flare visible?
- Girdling roots?

**Trunk:**
- Mechanical damage?
- Cankers, sunken lesions?
- Dry, flaking, neucrotic?
- Insects, especially scales

**Branches and Leaves:**
- Mechanical damage?
- Fungal cankers?
- Insects: scales, aphids, mites?
- Leaf size and color?

**Root Ball:**
- Synthetic burlap or twine?
- Wire basket?
- Appropriate sized ball per trunk caliper?
- Soil firm or loose?

**Container:**
- Standard pot or custom?
- Root bound?
- Appropriate sized for height and spread of plant?

***Note: All nursery stock should meet ANSI Z60.1 Nursery Standards.***

**INSPECTION OF ESTABLISHED TREES**

**Roots and Root Collar:**
- High root system?
- Girdling roots?
- Mower damage?
- Mulch mounded against trunk?
- Grass growing up to trunk?
- Root suckers?

**Trunk Condition:**
- Fungal cankers?
- Decay?

**Crown Condition:**
- Double leaders?
- Tight branch junctions with included bark?
- Crossing branches?
- Close to buildings, lights, other infrastructure.
- Dead branches?
- Excessive crown sucker growth?
- Deformed leaves?
- Leaves off color? Chlorotic?

# Appendix F

## *PLANTING RECOMMENDATIONS*

Planting strategies on Penn's campus must continue to evolve to enable it to truly function as part of the larger native ecology. The campus has already progressed in this direction thanks to efforts of the University Landscape Architect, Landscape Planner, Morris Arboretum, and Urban Park staff. Penn has drastically reduced mono-culture plantings of invasive species (such as English Ivy). Annual plantings have are being reduced and increasingly replaced by bulbs and perennials. Native species have become increasingly prevalent across campus. These efforts can still go further. Below is a list of principles for making future plantings more ecologically rich and easier to maintain:

**MAXIMIZE BIODIVERSITY**

Biodiversity gives plant communities resilience to disease and maximizes habitat value to native fauna. Aim for no more than 10% of any one species, 20% of any one genus, or 30% of any family within a given design. Existing statistics for perennials, groundcovers, and shrubs across campus needs to be determined. See *Appendix A: Implementation.* Further, ensure that planting designs incorporate the maximum amount of structural diversity that is practical for a given design intent, maximizing the use of canopy trees, understory trees, shrubs, and perennial layers.

**USE SITE CONSTRAINTS AS AN ADVANTAGE**

Conventional plantings often utilize a small range of species that are adapted to ideal landscape conditions: rich soils, moderate moisture, and high light levels. Maintenance efforts then revolve around maintaining ideal conditions through regular irrigation and fertilization. These conditions also invite highly competitive invasive species, which need to be weeded on a regular basis.

Plant communities can be designed to embrace challenging site conditions, both to minimize inputs and to provide a competitive advantage over invasive species. A planting approach based on J. Philip Grime's universal adaptive strategy theory should be utilized, balancing species with Competitive, Stress-Tolerant, and Ruderal (C-S-R) traits. For example, rather than irrigating dry soils within a rain garden, a mix of highly drought tolerant (S) species should be combined with quick spreading (R) species.

**COVER THE SOIL**

A designed plant community can include its own "living mulch". To do so involves utilizing spreading species that hug the ground. These species might appear as a conventional groundcover or may be intermingled under taller, more open species. This approach allows a plant community to better compete with invasive species while minimizing or eliminating the need for mulch.

**MIMIC NATURAL PLANT COMMUNITIES**

Natural plant communities are made up of a mix of species having varying "Levels of Sociability" as developed by Hansen, Stahl, and Müssel. Some species tend to remain isolated individuals, while others form groupings or masses of varying sizes. Designed plant communities should mimic this organization, combining broad swathes of "Seasonal Theme Species" and "Ground Cover" species with smaller percentages of more aggressive "Dynamic Filler Species" and individual "Structural Species".

**MAINTAIN A HIGH STANDARD OF BEAUTY**

For ecological plantings to be sustained within Penn's campus, they need to be more than adaptive and utilitarian- they need to be beautiful. Well loved, beautiful plantings are a powerful endorsement of an ecological landscape, ensuring that Penn's stewardship is supported and sustained.

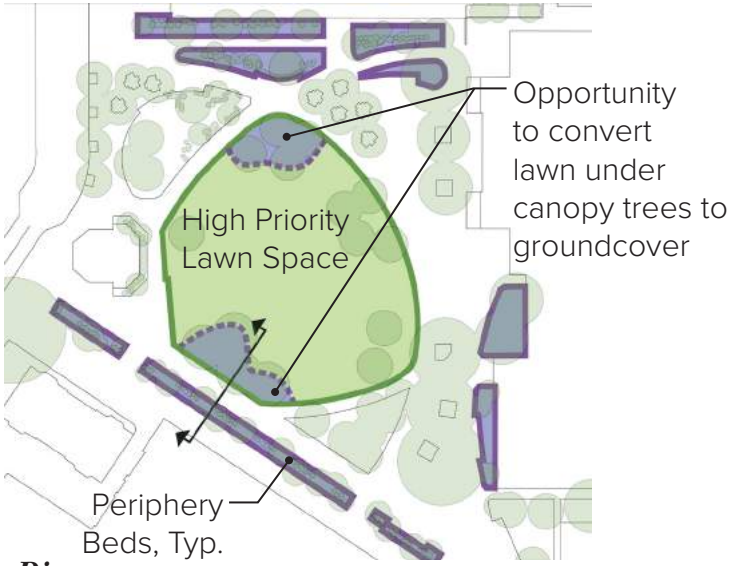
A beautiful planting design incorporates a number of characteristics:

• Unity through texture, color, or tone: this lends a sense of order and control, regardless of the actual species diversity. The degree of visual unity should relate to the formality of a landscape's specific context: more formal spaces should appear simpler and more unified, while informal space can appear more mixed and naturalized.

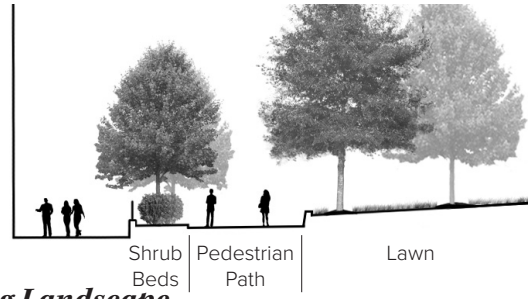
• Formal patterning or accents through contrasts in tone or texture: this creates interest and supports a level of structural diversity in the landscape.

• Seasonal color: a balance of evergreen species, foliage plants, and blooms emphasizing spring and fall brings varied interest throughout the academic year.

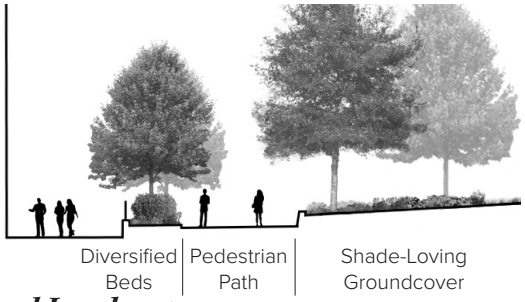
The following conceptual planting diagrams present possibilities for enriching campus landscapes, typified by the four pilot areas, utilizing the principles outlined above. An ecologically rich landscape requires that an ever-growing variety of species is used. Therefore, these plant palettes should not be taken as a template to "cut and paste" across campus, but rather a starting point upon which Penn's able design teams can build.




***Plan Diagram***




***Existing Landscape***




***Ecological Landscape***

## SHOEMAKER GREEN - PERIPHERY BEDS AND ROOT ZONES

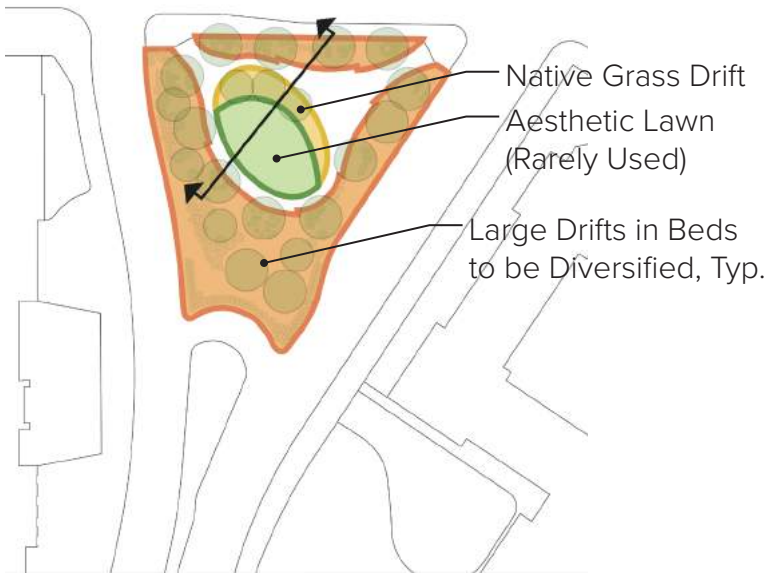
Shoemaker Green, as a Sustainable SITES Initiative pilot project, incorporates a variety of native species suitable for urban environments. The project serves as a model for the campus for integrating environmental and ecological functions into design.

During the course of the observations, it was observed that the periphery beds that line the paths adjacent to Franklin Field had a canopy layer and a shrub layer, but the perennial layer had died. Discussions with the groundskeepers revealed that the die-off was a result of irrigation issues that had since been resolved. Despite this fact, the plantings have yet to be replaced. Replacement plants for this zone should include massings of the following native groundcovers:

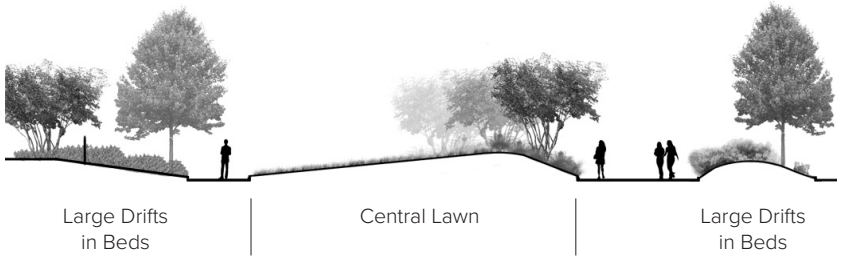
- *Carex pensylvanica*
- *Heuchera americana* 'Dale's Strain'
- *Pachysandra procumbens*

As well as replacing plantings that died during establishment, groundskeepers could provide additional groundcover underneath the canopy trees in the large lawn. In these instances, native species would contribute to a more beneficial soil biology and would allow more water resources for tree roots. Plants suggested for these areas include massings of the following native groundcovers:

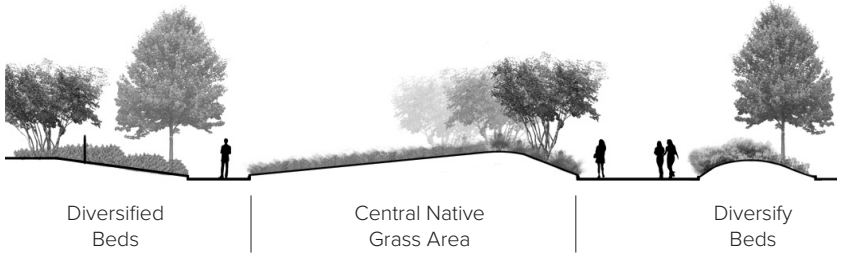
- *Carex laxiculmis* 'Hobb'
- *Carex pensylvanica*
- *Heuchera americana* 'Dale's Strain'
- *Osmunda regalis*
- *Polygonatum commutatum*
- *Pachysandra procumbens*




***Plan Diagram***




***Existing Landscape***




***Ecological Landscape***

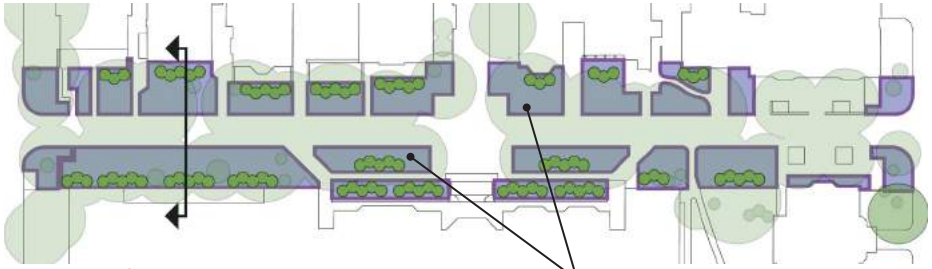
## KANE PARK - LAYERED PERENNIALS AND AESTHETIC LAWN

Kane Park's planting plan features a variety of canopy trees, understory trees, evergreen shrubs, and a relatively diverse palette of native perennial species arranged in large drifts. These drifts are provide bold visual swathes of texture. Some gaps exist in areas where perennials have not thrived, and on the groundplane under mid-height species like *Amsonia hubrichtii* and *Ilex glabra.* Aggressive ground hugging native species could fill these gaps and create a living mulch layer to deter weed growth. Suggested species for interplanting within these gaps include:

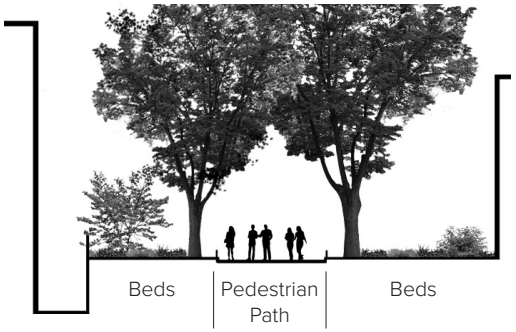
- *Symphyotrichum ericoides* 'Snow Flurry'
- *Geranium macrorrhizum* 'Ingwersen's Variety'
- *Hypericum calycinum*
- *Packera obovata*
- *Callirhoe involucrata*
- *Antennaria plantaginifolia*

The lawn area at Kane Park could also be enriched in a way that maintains a lawn's visual aesthetic, but provides more in the way of habitat and doesn't require the high degree of watering, fertilization, and weed control of a traditional lawn. Although further studies for exploring traditional lawn alternatives are suggested Appendix A, a massing of the following species would be a suitable alternative:

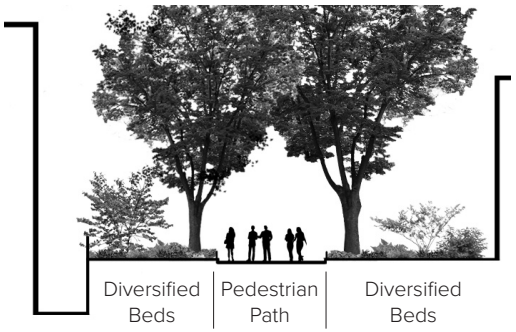
- *Bouteloua gracilis*




***Plan Diagram***




***Existing Landscape***




***Ecological Landscape***

## LOCUST WALK - ENRICHING UNDERSTORY

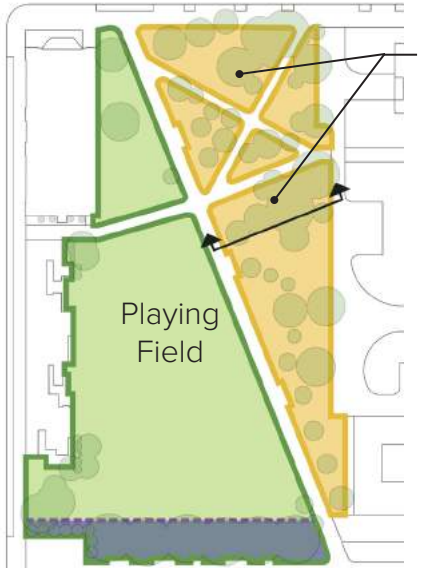
The tree-lined path of Locust Walk provides an iconic setting for high profile campus activities. The walk is lined by beds consisting of low woodland perennials and ground covers under arching canopy trees.

Disturbance remains a huge issue in this area, resulting in many gaps within the groundplane. Within these gaps there are opportunities to incorporate a greater diversity of native species, incorporating layers of spring and fall blooming perennials, evergreen foliage plants, and aggressive ground-hugging perennials to suppress weeds. Suitable species include:

- *Anemone canadensis*
- *Athyrium angustum forma rubellum*
- *Carex laxiculmis* ‘Hobb’
- *Chrysogonum virginianum var. australe.*
- *Erigeron pulchellus var. pulchellus* 'Lynnhaven Carpet'
- *Geum fragaroides*
- *Lobelia siphilitica*
- *Meehania cordata*
- *Onoclea sensibilis*
- *Penstemon digitalis*
- *Phlox divaricata*
- *Viola walteri*

Additional flowering understory trees and shrubs would provide extra habitat and spring interest. These should be incorporated closer to the buildings and include the following:

- *Chionanthus virginicus*
- *Hamamelis virginiana*
- *Rhododendron* ‘Delaware Valley White’




***Plan Diagram***

Lawn and Trees

***Existing Landscape***

Shaded Meadow

***Ecological Landscape***

## 40TH STREET FIELD - REPLACING UNNECESSARY LAWN

Several lawns exist within the 40th Street Field area. While the central Playing Field lawn is in frequent use, the lawns framing the site are rarely used. These spaces are characterized by low quality lawn scattered under a bosque of canopy and understory trees. The understory of this bosque could be greatly enriched with native trees, shrubs, and a shaded meadow of mixed perennials. Suggested species include:

Understory Trees

- *Amelanchier canadensis*
- *Carpinus caroliniana*
- *Cercis canadensis*
- *Cornus alternifolia*

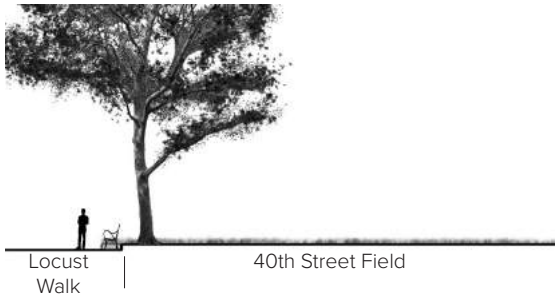
Shrubs

- *Amelanchier canadensis*
- *Carpinus caroliniana*
- *Cercis canadensis*
- *Hamamelis virginiana*

Perennials & Grasses

- *Asclepias tuberosa*
- *Bouteloua curtipendula*
- *Echinacea purpurea*
- *Elymus virginicus*
- *Liatris spicata*
- *Pycnanthemum flexuosum*
- *Ruellia humilis*
- *Schizachyrium scoparium*
- *Solidago juncea*
- *Symphyotrichum oblongifolium* 'Raydon's Favorite'
- *Penstemon digitalis*


***Plan Diagram***




***Existing Landscape***


***Ecological Landscape***

## 40TH STREET FIELD - LOCUST WALK BORDER

The 40th Street Field also lines Locust walk along its southern edge. Currently this area is represented by an allée of London Plane trees growing within lawn. There is an opportunity to extend the horticultural character of Locust Walk into this area, creating more visual interest and biodiversity, increasing the quality of soils for infiltration and tree health, and reducing mowing and watering requirements. Lower perennials and grasses should be positioned closer to Locust Walk, while shrubs should be positioned closer to the edge of the playing field in order to create a backdrop. A mix of native species has been selected to provide color in Spring and Fall, provide evergreen foliage, and create a resilient groundcover.

Perennials & Grasses

- *Aster divaricatus*
- *Athyrium angustum forma rubellum*
- *Carex cherokeensis*
- *Carex pensylvanica*
- *Chrysogonum virginianum*
- *Geranium maculatum*
- *Heuchera americana*
- *Solidago caesia*
- *Stylophorum diphyllum*

Shrubs

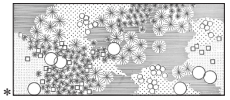
- *Fothergilla* ‘Mount Airy’
- *Ilex verticillata*
- *Itea virginica* ‘Henry’s Garnet’
- *Physocarpus opulifolius*

## Successful Plants and Planting Strategies for Cities and Green Infrastructure

Claudia West | claudia@northcreeknurseries.com
North Creek Nurseries, Inc. | www.northcreeknurseries.com | p: 877.ECO.PLUG

### Planting Design Strategies

Traditional horticultural planting treats plants like individual objects in space. Planting is largely based on flower color and texture. Blocks of different color/texture are arranged with on another for best visual effects.



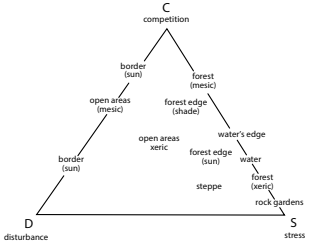
Today planting design is shifting to a more plant community based model. Plants are understood as overlapping populations made of individuals that grow along environmental gradients and interact with one another and their environment.

### Richard Hansen, Friedrich Stahl, Hermann Müssel: Levels of Sociability

Not all plants are equally suited as ground covers. Some species naturally occur in small clumps and others form larger populations. Levels are based on natural occurrence and indicate which arrangements are stable in planting.


### John Phillip Grime: C-S-R System

Grime divides plants into three categories: competitors (C), stress tolerators (S), and ruderal species (R). His system is based on descriptive ecology but can be useful for planting design. For example, a green roof planting is generally made of stress tolerant *Sedum* and a tall prairie on rich soil is most stable if planted from competitive species, such as *Panicum virgatum*. Ruderals on the other hand tolerate disturbance and are excellent for highly disturbed urban meadows.




### Plant Palette for Urban and Engineered Soils

**Structural Species (1-10%)**
*Eryngium yuccifolium*
*Rudbeckia maxima*
*Schizachyrium scoparium* 'Standing Ovation'

**Seasonal Theme Species (30-40%)**
*Monarda bradburiana*
*Pycnanthemum flexuosum*
*Symphyotrichum oblongifolium* 'Raydon's Favorite'
*Vernonia lettermannii* 'Iron Butterfly'

**Ground Cover Species (30-40%)**
*Bouteloua curtipendula*
*Carex amphibola*
*Eragrostis spectabilis*
*Deschampsia cespitosa*

**Dynamic Filler Species (5-10%)**
*Chrysopsis mariana*
*Juncus tenuis*
*Ruellia humilis*

* Illustrations after Hansen, Richard and Friedrich Stahl. Perennials and Their Garden Habitats. 4th ed. Portland, OR: Timber Press, 1993.

# Appendix G

## *IRRIGATION PRACTICES*

As Penn's campus moves toward a more ecological landscape, the species makeup will become increasingly native and drought tolerant. This drought tolerance is not only good for minimizing water usage, but it also gives the preferred native species a competitive advantage over invasive species. Further, by minimizing irrigation within planting beds, foliar diseases and root-rot can be avoided. Planting beds containing designed plant communities of perennials, shrubs, and trees should move away from permanent irrigation systems. Hand watering should be used for newly installed plants during the first two years of establishment.

Lawns, however, will remain dependent on irrigation. Even the most drought tolerant and diverse lawn mixes are subject to drought stress. Engineered soils make lawns even more prone to drought, as these soils depend on a high sand content to resist compaction. While water ***use*** is not a major ecological concern within the wet climate of the Mid-Atlantic, stormwater runoff is a major problem - one that irrigation systems can help mitigate. Stormwater should be collected and used to irrigate lawns, as is currently done at Shoemaker Green. Penn's 2013 Stormwater Master Plan identifies potential locations for stormwater collection across campus, many in locations adjacent to well utilized lawns. Stormwater collection and lawn revitalization efforts could be combined into localized, joint projects.

# Appendix H

## *BUDGET INFORMATION*

Penn currently spends $2,600,000 annually on wages for Groundskeepers and Hard Surfaces Staff, at a maximum $21.94/ hour rate. The ***ELSP*** proposes elevating five groundskeepers to "Skilled Gardener" positions, including a roughly $5.34/hr increase in pay. This pay rate would put them on par with the average salary for First Line Groundskeeping Supervisors in the Philadelphia area. (Bureau of Labor Statistics, 2015). The Skilled Gardener positions are expected to provide the level of ownership needed to generate a substantial increase in efficiency amongst grounds crews, and eliminate the need for additional crewmembers. The Skilled Gardeners position will increase Penn's wage spending to $2,656,730.00.

Penn spends an additional $870,000.00 per year on third party landscape maintenance contracts, which includes additional tree, mowing, and landscape work. Anticipate a slow decrease in spending on mowing and lawn upkeep as select areas are converted into more richly vegetated beds.

Budget figures for tools, plants and materials were unavailable. To work towards the goals of this ***ELSP***, Penn should anticipate increased spending on tools and upkeep, and a gradual decreased spending on mulch and annuals. There will be short

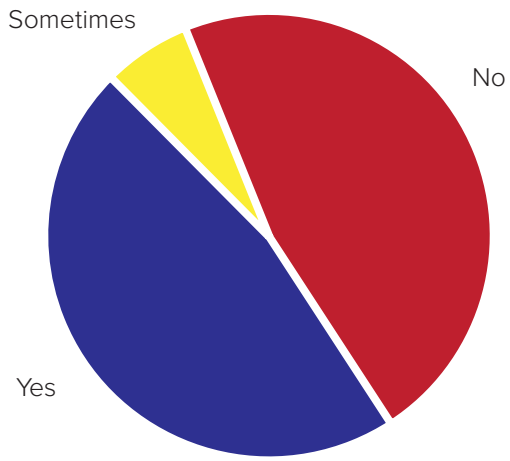
term increases in spending on perennials and bulbs as planting areas become enriched over the next ten years, with a long term spending decrease as those areas become established and self-sustaining.

# Appendix I

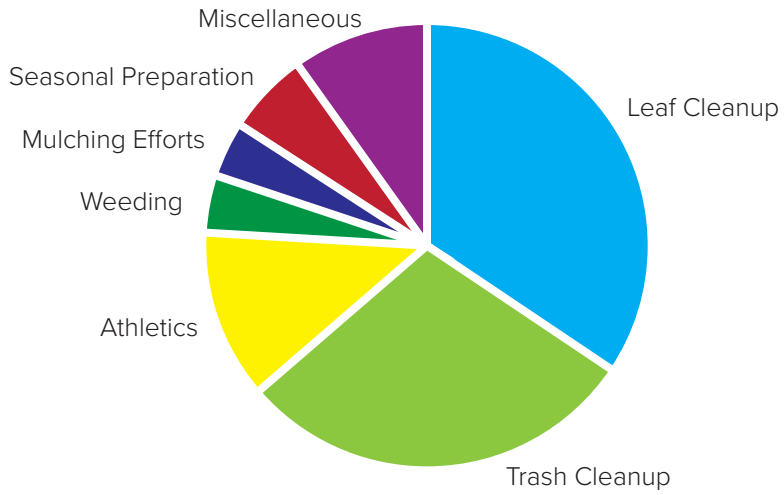
## *GROUNDSKEEPER SURVEY RESPONSES*

A questionnaire was distributed to Penn's grounds and hard surfaces staff in September 2016 in an effort to better understand their experiences and attitudes as stewards of the campus landscape. Of the total fifty-seven (57) employees, thirty-two (32) responded. These responses are subjective, but they shed light on their experience. A summary of the most illuminating questions and responses follows. Detailed responses have been provided as a supplemental document.

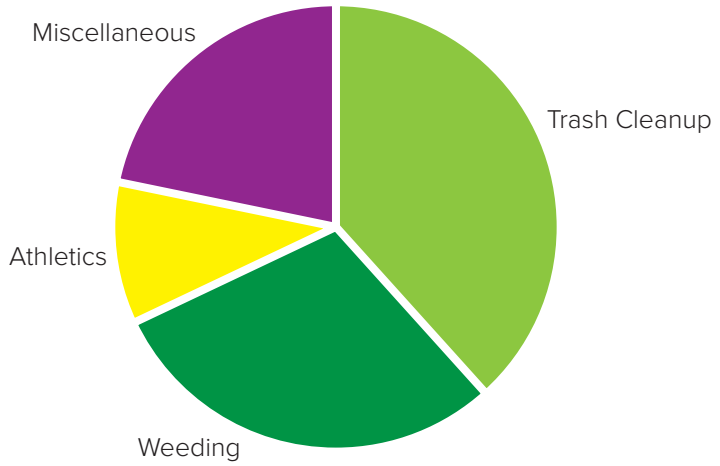
***Do you feel like you have access to the tools and equipment that you need?***



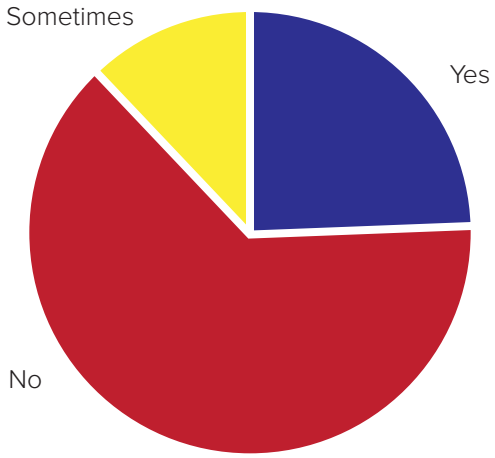

***What are the three most time consuming daily tasks in the fall?***



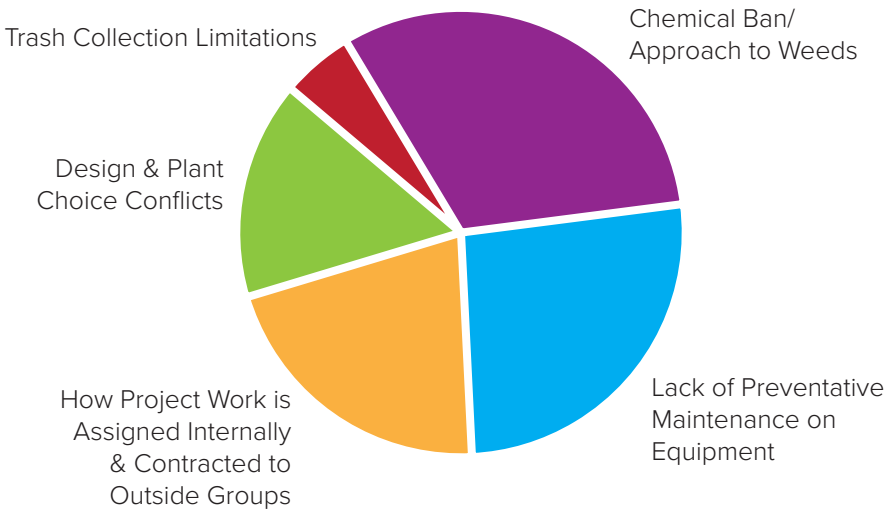

***What are the three most time consuming daily tasks in the summer?***



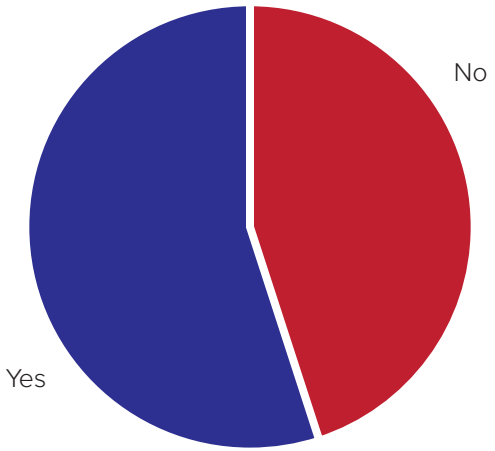
***Do you have control over the way in which your daily tasks are scheduled?***



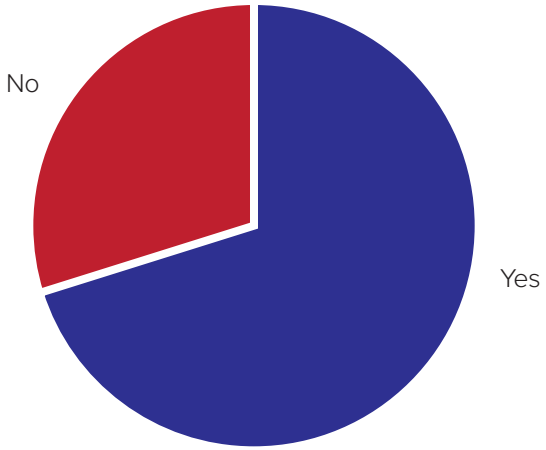

***Are there maintenance practices that you find counterproductive?***



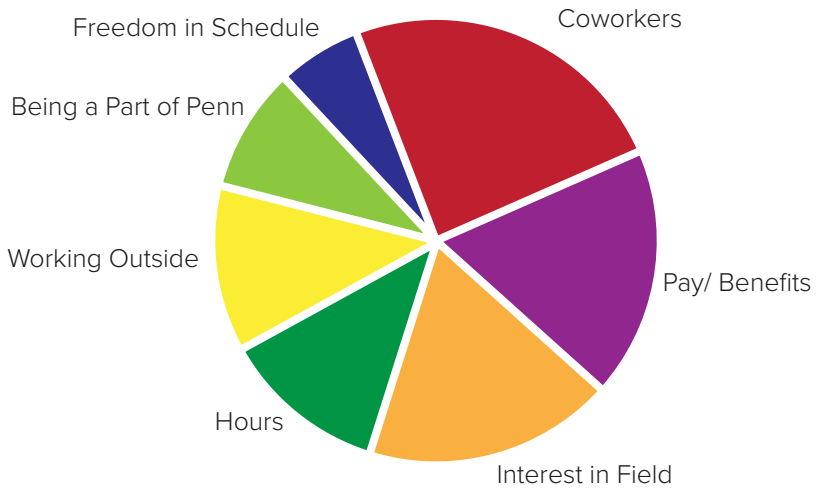

***Would you propose any changes to your daily schedule?***



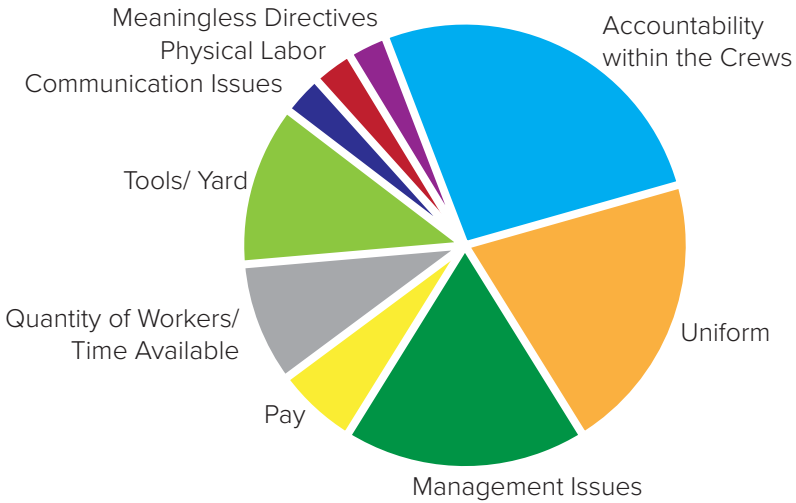
***Would you like to take classes or seminars that further your understanding of sustainability in landscape management?***



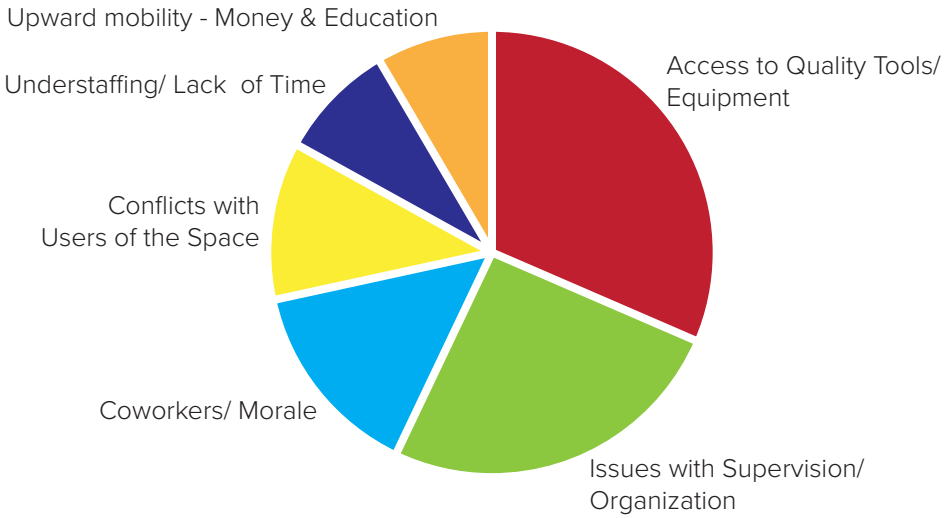

***What do you like most about your job?***



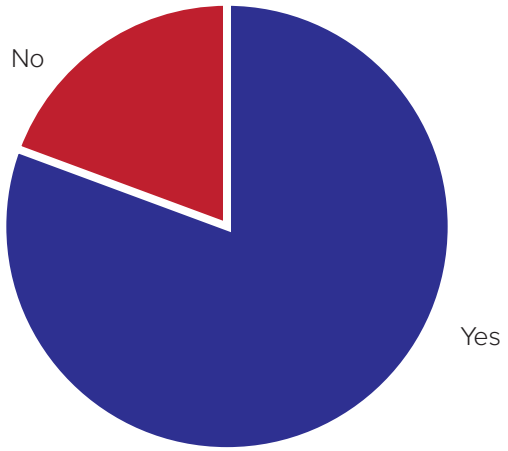

***What do you like least about your job?***



***What are your biggest hurdles?***




***Do you hope to continue to work in the Urban Park crew for the foreseeable future?***



# Appendix J

## *SITES MAINTENANCE MANUAL*

This section includes the original text from Shoemaker Green's maintenance manual, part of the required submission for the Sustainable SITES Initiative. This manual has been partially adhered to. The turf care and fertilization routine was followed as described in the manual. However, selective pruning and mulching requirements for perennial areas are not always followed, largely because this information was not fully communicated to the Penn Parks crews.

Operation of the stormwater collection system was challenging, as a new system had to be mastered and incorporated into Penn's institutional knowledge. Much of the system monitoring has only recently been restored due to the investigative work of Dr. Vann and his colleagues. Efforts to improve future hand-off of design knowledge to maintenance crews are addressed in Appendix B.

Note: For this *ELSP*, the text has been highlighted to identify specific measures that are applicable to the entire campus.

# 1 INTRODUCTION

The Shoemaker Green project is a design that is based on performance and a thorough understanding of natural systems and how these systems function within the built environment.

This approach requires a paradigm shift in how we think about the landscape. Each component from the existing site materials, soils, water, vegetation, insects, wildlife, and humans all play a role in a healthy functioning ecological system. It is from this system based thinking that the design of the Shoemaker Green project evolved.

The site will be part of a two year University Monitoring study in collaboration with Andropogon Associates. Careful monitoring of the natural biological systems at the site will dictate maintenance needs and treatment methods prescribed. The maintenance protocols outlined below are intended as a guide for monthly and annual landscape maintenance. Although based on existing regimes that may be familiar to many staff members, it is imperative communications are constant between crew members, leaders, managers, and researchers so the landscape is a success.

# 2 GENERAL MAINTENANCE **(guidelines only not for bidding purposes)**

## 2.1 Pruning

Trees and Shrubs – see additional illustrations for pruning techniques
NOTE LEADER PRUNING DOES NOT APPLY TO SHRUBS

Selective pruning shall be performed by hand with a sharp pruning instrument. Trees and shrubs should be allowed to grow together naturally and not be pruned into balls or individual shrubs. All pruning shall conform to ANSI and International Society of Arboriculture standards.

Trees and shrubs shall be maintained at the required height for safety and security purposes. The University DPS will regularly inspect and provide recommendations.

The Green Campus Partnership Program (GCPP) regularly consults with industry professionals such as the Morris Arboretum, specific recommendations should be followed first and general maintenance assessed regularly.

General guidelines included: first removing limbs that are dead, damaged, or diseased and then removing a few specific limbs that prevent crisscrossing and allow more air flow through the canopy, without compromising the aesthetics of the tree. Selecting the few limbs that will be most productive for the tree requires a trained professional.

See Photo Inventory for plant specific pruning details. Note, some plants have different pruning times depending on blooming physiology, thus THE PHOTO INVENTORY MUST BE READ PRIOR TO ANY PRUNING.

Grasses and Perennials

Selective pruning may be required throughout the season to remove old (spent) seed heads and any unsightly material. Note if there is excessive browning or unusual discoloration there may be an underlying problem and a supervisor should be notified.

All grass and perennial material should be pruned to the ground in late winter. All pruned material shall be removed off site.

## 2.2 Mulching

Planting beds shall be maintained with yearly applications of triple ground hardwood bark mulch. No dyed mulch is to be used. The mulch must be obtained from a reputable source so it is free of weed seeds, deleterious material and insects.

Mulch applications should be maintained at a total level of 2-3". Note this might require old mulch to be removed or only topdressing with 1" or less of mulch. Care should be taken not to over-mulch planting beds or allow much to build-up over time. Mulch applications will need to be feathered to a height of 1" or less at the base of trees and shrubs and around perennials.

Mulch should be applied after compost tea applications. Compost tea improves microbial activity in the soil and application to the mulch may facilitate mulch decomposition.

**DO NOT bury perennial plants, root flares on trees and canes of shrubs.**

## 2.3 Turf Care

Maintain lawn areas with watering, weeding, mowing, and replanting as necessary. The frequency of mowing shall be determined by the growth rate which will vary depending on seasonal weather conditions.

The turf area is a 3 blend mix of Festuca arundinacea (turf-type tall fescue). This blend was utilized for its strong / deep root system and drought tolerance. The recommended maintenance height of this grass is 2-3". Mow the turf when the height is 1/3 to ½ higher than the recommended height. In general more mowing will be necessary in the spring and fall as Tall Fescue is a cool season grass, however the supplemental irrigation may induce stronger growth during peak summer months so the turf should be monitored and mowed as needed.

**DO NOT mow when grass is wet.**

**DO NOT let the grass grow too tall or mow too short.**

**DO NOT remove more than 1/3 of the height of the grass**.

Change mowing patterns each time the lawn areas are mowed. It is the responsibility of *project manager of the contracted maintenance company* to keep up to date records of which way the lawn was mowed at the previous visit. All mowing equipment is to be properly maintained and the blades sharpened monthly.

Care should be taken when refueling or adjusting equipment on site.

Restrict the use of the lawn area before and after large events. Events shall be scheduled so that no more than two heavy uses per week are allowed. For every day of "heavy use", 36 hours of recovery time use restrictions shall be employed. Compost tea applications must occur **immediately** after heavy use events; see fertilizer section for details.

## 2.4 Watering

An automatic watering system has been installed on site with soil sensors and other weather monitoring features. The system should self-adjust accordingly however, general observations should be made to assure the system is working properly. The turf should receive a minimum of 1 inch per week of water, either from natural precipitation or through supplemental irrigation. Trees, shrubs, perennials, and groundcovers generally require less water than turf areas.

During drought periods when the turf leaf blades have lost turgidity, the leaf blades do not bounce back quickly after compression, i.e. if you walk on the grass the outline of your footprint will remain. If the lawn is under water stress during a drought, irrigate based on plant needs only to keep turf from folding, and do not mow grass.

The irrigation needs of the site should be monitored by the facilities manager and the automatic controllers adjusted as necessary.

If supplemental irrigation methods are used such as hand watering, care must be taken not to water system sensors. This could result in inaccurate readings and cause other plant material to suffer.

## 2.5 Fertilizers

General fertilization requirements include:

A. The landscape maintenance contractor (LMC) shall provide all the necessary resources for a program that will consist of testing soil, accountability field tests and must respond to variations of growth and weather. All labels from off the shelf products must be handed in after each application along with copy of receipt.

B. Liquid Biological Amendment must be custom brewed and applied within 10 hours of finished production. Compost Tea Brewing manuals available at Soilfoodweb.com

C. In the event that the routine application scheduled is determined to be excessive or inadequate, the LMC will immediately contact the Facilities Services representative to discuss the required changes. These variations should be considered in the LMC's base cost.

**D. The fertilization plan for campus is intended to provide a uniform sustained growth pattern in a natural and sustainable manner to eliminate the use of all synthetic materials.**

E. In spring apply liquid biological amendment at the rate of 10 gallons of concentrate per 1000 square feet of turf or based on benchmark levels
Mix Organic Materials Review Institute (OMRI) approved soluble humid acid at the rate of 4 ounces per 50 gallons of solution.
Mix OMRI approved kelp at the rate of 4 ounces per 50 gallons of solution.

F. In mid-summer measure the root depth by plug or core sample at random turf locations. Root depth should be 4-6 inch depth.
Spot treat Disease prone areas with a Fungal Liquid Compost Tea
Apply 8 pounds of feather meal based granular fertilizer per 1000 square feet of turf.

G. In fall obtain soil samples for analysis and measure root depth.
Apply liquid biological amendment at the rate of 10 gallons of concentrate per 1000 square feet of turf or based on benchmark levels.
Mix OMRI approved soluble humid acid at the rate of 4 ounces per 50 gallons of solution Mix OMRI approved kelp at the rate of 4 ounces per 50 gallons of solution.

H. Soil tests must be taken every 50,000 square feet of turf and sent to for chemical analysis, and to soil Foodweb Oregon for complete biology test (bacteria, fungi, Protozoa and nematodes). Results of these tests shall be submitted to the University as a report.

I. Soil pH shall be maintained in the range of 6.2 to 6.8 at all times throughout the year.

J. Soil testing shall include at a minimum a basic soil test to include: Organic matter (Colorimeteric up to 9.9%), estimated nitrogen release, available phosphorus, (P1, weak bray and P2 , strong bray), exchangeable potassium, calcium, magnesium, hydrogen, soil pH, buffer pH, cation exchange, capacity and percent base saturation of cation elements. Also include, a sodium bicarbonate, sulfate sulfur, zinc, manganese, iron, copper, and boron test

## 2.6 Rain Garden and Stormwater Features

Please note the stormwater facilities at Shoemaker Green are part of a University monitoring study that will take place for a minimum of two years, maintenance regimes may vary depending on research data needed. Any adjustments or changes will be communicated to the GCPP.

Once established selective mulching of bare areas in rain garden may be necessary, mulch may migrate and collect in drain areas. Check drain areas regularly and remove mulch from drains and swales.

Inspect overflow areas regularly and keep free and clear of leaves and debris.

On a regular basis keep inlet trench drains clear of litter and debris to assure water is unobstructed and is conveyed as designed. Remove any trash and debris from stone swale area.

Inspect underdrain cleanout and remove sediment and debris build up on a biannual basis.

Verify drained out time of system on a biannual basis.

Regularly maintain records of all inspections and maintenance activity.

Do not use any chlorine or bromine based products to clean any water features on site. As stormwater features no typical cleaning should be necessary however, if cleaning products are needed only biodegradable, environmentally sensitive cleaning products are to be used. All receipts for products used must be handed in to the Facilities department.

Refer to the **PWD Stormwater Management** Guidelines for additional maintenance criteria.

Weed rain garden regularly, see Photo Inventory of aggressive weed species in rain gardens. Consult Landscape Architect for any necessary design adjustments / plant substitutions.

### 2.7 Soils

Prohibit and/or limit pedestrian and equipment access to all planting areas. Maintenance of planting beds shall be limited to light foot-traffic.

The soils at Shoemaker Green are under a University monitoring study to evaluate soil microbial composition and their relationship to stormwater. All maintenance recommendations for the first two years will be provided by the GCPP. Preliminary guidelines include:

- Subcontractors are responsible for providing lab analysis of all applied materials.

- Compost tea applications are subject to random quality control testing.

- Detail records must be kept of what and when any substances are applied to the site, i.e. herbicides, pesticides, salt composition.

Additional guidelines will follow as seasonal testing results, yet to be performed, of both soils and stormwater will dictate future maintenance regimes. Compost tea applications will be a dominate factor in the expected regimes. It is anticipated the correct composition of the compost tea will promote healthy soil and plants thus that no other fertilizer maintenance other than compost tea applications will be necessary.

### 2.8 Irrigation

The irrigation system needs to be winterized each fall. All lines need to be blown out and left open. Valve at cistern needs to be closed.

### 2.9 Stone Benches and Walls

Monitor stone for any damage and save any chipped pieces as they may be able to be reset. Deter skateboard and bike activity from damaging walls and benches.

For cleaning, the fabricator recommends a mild soap and scrub brush or pressure washing if it's a food stain. For grease use a standard household spot remover, which might make the stone a little brighter than the surrounding area but that will settle out with weathering.

### 2.10 Litter Control and Trash Removal

Litter should be picked up and removed from the site on a daily basis.

### 2.11 Snow and Ice Maintenance

If snow piling is necessary, mound the snow in seating areas only. DO NOT pile the snow in the lawn area or in planting beds, this may compact the soil and inhibit healthy plant growth.

Current University policies dictate the use of a magnesium chloride base product for snow removal. Although less toxic than traditional sodium chloride products, it is still a form of rock salt, which can be highly detrimental to plant material.

To reduce plant and soil degradation it is imperative just before winter ends and the last anticipated use of rock salt, a 10% organic matter application be applied to any plant / soil ground surfaces that may come in contact with salt residues. Salts kill beneficial soil microbes that promote strong plant growth. These microbes go dormant in the winter and during spring thaw periods the excess salt concentrations, due to winter application residues, kill the microbes. The application of organic matter will counteract the salt molecules and buffer the microbes from harm. See fertilization section for organic matter composition details.

To reduce excess salt accumulations the magnesium chloride products should only be used after snow fall as a deicer not prior to as an anti-icer, this will prevent unnecessary use of the product. Deicers should be used as a liquid application at the minimal rate necessary to achieve safety goals.

When snow fall is one inch or greater the area should be plowed and the deicer applied after plowing.

### 2.12 Controls

As part of the monitoring program control areas are being identify to compare to Shoemaker Green. It is anticipated the research will use areas outside of Shoemaker Green

however, at this time these control areas have not been established. When identified all personnel are to made aware of the parameters being tested and where the control locations are so data is not misrepresented.

## 2.13 Integrated Pest Management

The integrated pest management practices are part of a University Monitoring study. It is anticipated that a holistic maintenance regime at Shoemaker Green will significantly reduce or eliminate the need for chemical weed or pest control.

Soils will be monitored for proper microbial activity and beneficial microorganisms. Proper soil health will promote strong plant growth and limit the ability for unwanted weeds to establish. Healthy, strong plants will also deter unwanted insects and diseases.

The plant material will be monitored by the GCPP and specific controls for insect or disease problems will be provided if necessary.

Weeds and invasive plant seedlings should be removed immediately. The seedlings should be hand pulled and care should be taken to remove the entire root with minimal soil disturbance.

If any other method of weed removal is used besides hand pulling the soils must be tested for proper microbial activity. Any substance will alter soil biology and could cause detrimental effects, especially Round-Up. It is for this reason it is suggested Round-Up not be used at all on Shoemaker Green.

Hand pulling may not be effective on some persistent perennial weeds. Spot treatment using organic products can be used if needed. Molasses applications for nut sedge removal at a rate of 20lbs per 1000 sq ft. or vinegar spray applications can be used, see recipe below (retrieved from www.organicauthority.com ).

**Vinegar Herbicide Formula:**

1 gallon of 10% (100 grain) vinegar
Add 1 ounce orange oil or d-limonene
Add 1 tablespoon molasses (optional - some say it doesn't help)
1 teaspoon liquid soap or other surfactant (I use Bio Wash)
Do not add water

Shake well before each spraying and spot spray weeds. Keep the spray off desirable plants. This spray will injure any plants it touches. This natural spray works best on warm to hot days.

Vinegar sprayed on the bases of trees and other woody plants will not hurt the plant at all. This technique was first learned about by spraying the suckers and weeds growing around the bases of grapevines. Avoid all vinegar products made from glacial acetic acid.

## 2.14 Wildfire Prevention

- Trees and shrubs pruned six to ten feet from the ground.

- Excess leaf clutter and dead plant material kept clear

- Prune overhanging branches

- Keep lawn short and dispose of cutting and debris promptly.

- Store wood and combustibles away from structure.

- Adhere to local regulations regarding vegetative clearance, debris disposal, and fire safety requirements for equipment.

## 4 US EPA INVASIVE PLANTS IN THE MID-ATLANTIC STATES (see pictorial index)

Purple loosestrife (Lythrum salicaria)
Bamboos (Bambusa, Phyllostachys, Pseudosassa species)
Chinese silver grass (Miscanthus sinensis)
Japanese barberry (Berberis thunbergii)
Privets (Ligustrum species)
Burning bush (Euonymus alata)
Bradford pear (Pyrus calleryana 'Bradford)
Norway maple (Acer platanoides)
Princess tree (Paulownia tomentosa)
Mimosa tree (Albizia julibrissin)
Bush honeysuckle (Lonicera species)
Japanese honeysuckle (Lonicera japonica)
English ivy (Hedera helix)
Oriental bittersweet (Celastrus orbiculatus)
Porcelainberry (Ampelopsis brevipedunculata)
Chinese and Japanese wisterias (Wisteria sinensis, Wisteria floribunda)

### USDA PENNSYLVAINA STATE NOXIOUS WEEDS

Cannabis sativa L. (marijuana)
Carduus nutans L. (musk thistle, nodding thistle)
Cirsium arvense (L.) Scop. (Canadian thistle)
Cirsium vulgare (Savi) Ten. (bull thistle, spear thistle)
Datura stramonium L. (jimsonweed)
Galega officinalis L. (goatsrue)
Heracleum mantegazzianum Sommier & Levier (giant hogweed)
Lythrum salicaria L.1 (purple loosestrife)

Polygonum perfoliatum L. (mile-a-minute)
Pueraria montana (Lour.) Merr. var. lobata (Willd.) Maesen & S. Almeida(kudzu-vine)
Rosa multiflora Thunb. (multiflora rose)
Sorghum bicolor (L.) Moench (shattercane)
Sorghum halepense (L.) Pers. (johnsongrass)

COMMON TURF WEEDS

Crabgrasses
Goosegrass
Foxtails
Barnyard grass
White clover
Dandelions
Johnson grass
Quack grass
Nut sedge

## Tree and Shrub Photo Pictorial and Pruing Guidelines

| | MARCH - MAY | JUNE -JULY | AUGUST - OCTOBER | NOVEMBER - FEBRUARY |
|---|---|---|---|---|
| Acer rubrum - Red Maple | | | | |
| Carpinus caroliniana - Hop Hornbeam | | | | |
| Carya ovata- Shagbark Hickory | | | | |
| Liriodendron tulipifera - Tulip poplar | | | | |
| Nyssa sylvatica - Black Gum | | | | |
| Quercus alba - White Oak | | | | |
| Quercus bicolor - Swamp White Oak | | | | |
| Quercus phellos - Willow Oak | | | | |
| Ulmus americana - American Elm 'Liberty' | | | | |
| Amelanchier laevis - Serviceberry | | | | |
| Cornus Florida 'Cherokee Chief Flowering dogwood | | | | |
| Cornus Florida 'Princess' Flowering dogwood | | | | |
| Hamamelis virginiana - Witch Hazel | | | | |
| Magnolia virginia - Sweebay Magnolia | | | | |
| Clethera alnifolia Hummingbird Clethera | | | | |
| Fothergilla gardenii - Dwarf Fothergilla | | | | |
| Hydrangea arborescens 'Annabelle' Annabelle Hydrangea | | | | |
| Hydrangea quercifolia 'Snow Queen' Snow Queen Oakleaf hydrangea | | | | |
| Ilex Glabra 'Densa' - Inkberry Holly | | | | |
| Ilex verticillata 'Red Sprite' Red Sprite Winterberry Holly | | | | |
| Itea virginica 'Henry's Garnet' Henry's Garnet virginia Sweetspire | | | | |
| Viburnum trilobum High Bush Cranberry | | | | |
| | | | | |
| | | | | |

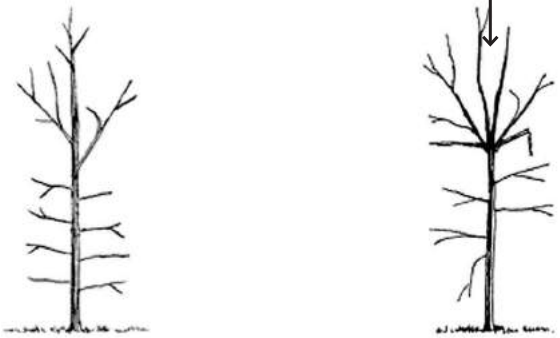
## Pruning Guidelines for Newly Installed Plants ( 3 years or less)

### Tree Pruning Steps at Planting

Leave as much of the entire leaf surface as possible to manufacture food that will build a larger root system. Roots will be larger after one year if left unpruned.

Do prune the following and trim close to the trunk:

- Broken branches.
- Branches competing with the leader. remove the weaker of the two branches
- Swollen branches from insect eggs or stings.
- Remove tree tags.



Good Bad

Learn Pruning Techniques with our Virtual Pruning Guide.

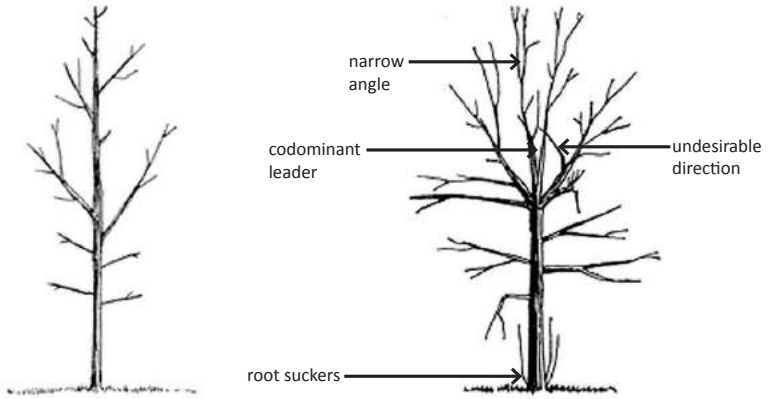
Images: The Arbor Day Foundation, Lincoln Nebraska.
http://www.arborday.org . Accessed on 10.15.12

## Pruning Guidelines for Trees 3 - 4 Years Installed

### Tree Pruning: After 3 to 4 Years

Root growth should be well on its way to anchoring the transplant and expanding the size necessary to nourish the growing branches.

- Cut off root suckers and sprouts in the crown.
- Thin excessive branches to reduce competition for light, water, and nutrients.
- Remove codominant leader.
- Remove a few of the lowest limbs but others are temporarily left to help the trunk develop more taper and strength.
- Eliminate branches that rub or growing in undesirable direction.
- Remove narrow angled branches.




Good Bad

Learn Pruning Techniques with our Virtual Pruning Guide.

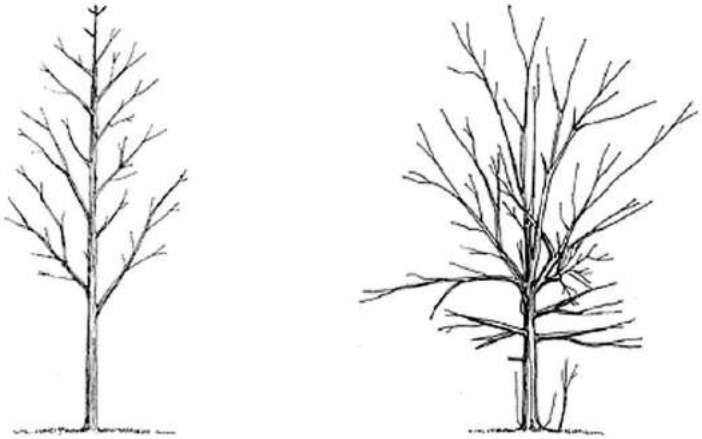
Images: The Arbor Day Foundation, Lincoln Nebraska.
http://www.arborday.org . Accessed on 10.15.12

## Pruning Guidelines for Trees 5 - 7 Years Installed

### Tree Pruning: After 5 to 7 Years

Now it is time to make a good tree even better.

- Lower limbs are pruned off to raise the bottom of the crown well out of the way of human heads. The lowest limbs are now permanent limbs. Please note: branches DO NOT move upward as a tree grows taller. The center of a branch at 5 feet will always be at 5 feet.
- Cut back a few of the higher up branches so they don't protrude beyond the graceful outline of the crown. see photo sheets for what natural shape of tree looks like
- Inspect tree to see if you need to remove a branch here or there for even spacing.



Good Bad

Learn Pruning Techniques with our Virtual Pruning Guide.

Images: The Arbor Day Foundation, Lincoln Nebraska. http://www.arborday.org . Accessed on 10.15.12

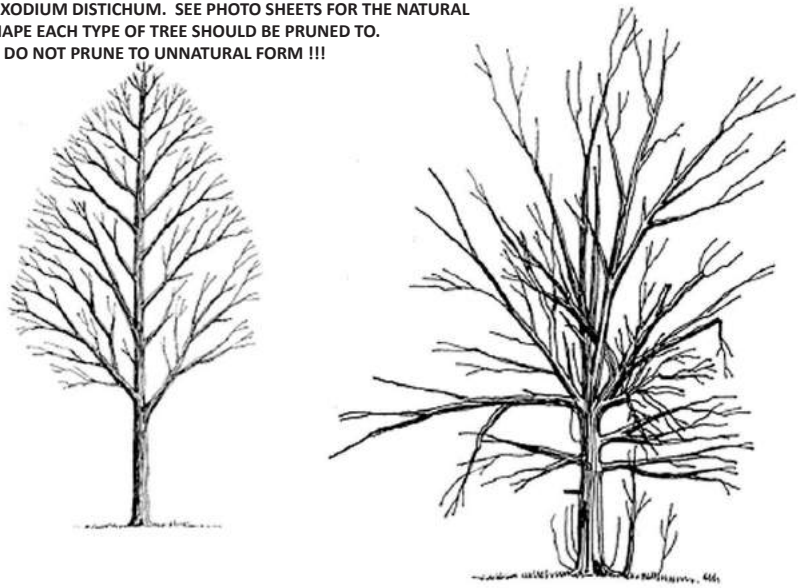
## Pruning Guidelines for Trees Installed 15 years or longer

### Tree Pruning: 15 Years After Planting

With proper pruning at the beginning of your trees life your tree will have a better chance of surviving extreme conditions such as wind storms, ice, and drought. That is because proper pruning gave strength to the branches.

Early each spring, look for dead or damaged limbs. If you do have dead or damage limbs remove using proper pruning methods. (disinfect pruning instruments between use)

**NOTE THE SHAPE OF THIS TREE IS TYPICAL OF A TREE SUCH AS THE TAXODIUM DISTICHUM. SEE PHOTO SHEETS FOR THE NATURAL SHAPE EACH TYPE OF TREE SHOULD BE PRUNED TO.**
**!!! DO NOT PRUNE TO UNNATURAL FORM !!!**



Good Bad

Learn Pruning Techniques with our Virtual Pruning Guide.

Images: The Arbor Day Foundation, Lincoln Nebraska. http://www.arborday.org . Accessed on 10.15.12

## Tree and Shrub Photo Pictorial and Individual Pruing Guidelines

Acer rubrum
Red Maple

Maples should be pruned in late summer or fall. Sap flow is more active in late winter and pruning then may leave unattractive streaks on the bark.

Follow general maintence guidelines.

Maples naturally form a round symmetrical canopy and little shaping will be necessary.

Carpinus caroliniana
Hop Hornbeam

Like red maples, hop hornbeams are also spring flowing sap trees. Thus they are better pruned in late summer or fall.

Follow general maintenace guidelines.

Hop hornbeams can develop an irregular shape and may need some specific pruning to make sure it does not crowd out / into other trees.

Carya ovata
Shagbark Hickory

Prune trees in late summer.

The bottom limbs branch down with increased drooping with age. Be sure to prune lower limbs appropriately to maitain views within the site.

Nut drop in the fall may need to be cleaned up along walks and pathways.

Follow general maintenance guidelines.

Liriodendron tulipifera
Tulip poplar

Prune in winter for best results.

The tree is prone to sun scald during winter. If this occurs use a heavy knife to cut out the dry / sunken bark back to live wood. The cut should be painted after removal to ensure proper tree health. Consult an arborist prior to correcting sunscald.

Follow general maintenace guidelines.

## Tree and Shrub Photo Pictorial and Individual Pruing Guidelines

Nyssa sylvatica
Black Gum

Prune in late summer / fall.

Insects are common visitors to the tree thus some spotting or chewing may be noctiable on the leaves. The trees should be monitored and only treated if sgnificant damage is going to occur.

As the tree matures upper branches shade out lower branches and over time dead limbs will need to be pruned from the bottom.

Follow general maintenace guidelines.

Quercus alba
White Oak

Prune in late winter or early spring.

Even long after establishment this tree has difficulty adjusting to compaction. The root zone area should be checked for good aeration.

Follow general maintenace guidelines.

Quercus bicolor
Swamp White Oak

Prune in late winter or early spring.

The tree regularly sprouts secondary branches thus pruning should be specific to propmote strong leaders a avoid a lot of stubby secondary branches.

Follow general maintenace guidelines.

Quercus phellos
Willow Oak

Prune in late winter or early spring.

Similar to other oaks, bottom branches may need to be pruned to allow for views within the site.

Prune for shape when young to promote strong form with age.

Follow general maintenace guidelines.

## Tree and Shrub Photo Pictorial and Individual Pruing Guidelines

Ulmus americana
American Elm 'Liberty'

Prune in fall

This cultivar is resistant to Dutch Elm Disease and will produce a graceful canopy shape with little pruning intervention.

When young prune the tree to promote a strong central leader.

Follow general maintenace guidelines.

Amelanchier laevis
Serviceberry

Prune in winter

The tree has a general multi-stem habit however root suckers should be removed and canes should be pruned to promote 3-4 strong leader canes.

Prune to prevent criss crossed limbs.

Follow general maintenace guidelines.

Cornus Florida 'Cherokee Chief'
Cherokee Cheif flowering dogwood

Prune in late winter or early spring.

Prune off a few selctive limbs do not prune part of a limb.

Follow general maintenace guidelines.

Cornus Florida 'Princess'
Princess flowering dogwood

Prune in late winter or early spring.

Prune off a few selctive limbs do not prune part of a limb.

Follow general maintenace guidelines.

## Tree and Shrub Photo Pictorial and Individual Pruing Guidelines

Hamamelis virginiana
Witch Hazel

Prune in late winter.

Prune to maintain shape.

Follow general maintenace guidelines.

Magnolia virginia
Sweebay Magnolia

Prune in late summer.

The small tree will naturally form an open canopy. Suckers and random limbs should be pruned up from the base.

Follow general maintenace guidelines.

Clethera alnifolia 'Hummingbird'
Hummingbird Clethera

Prune in summer.

Clethera produces the strongest blooms on one year old wood and suckers regularly. To maintain current aesthetics and prune to provide for the following aesthetics branches should be selectively cut for maximum blooms. Cut approximatley 50% of the blooming wood down to the base to open the canopy for the sucker or year old wood to grow and produce blooms for the follwoing year. Thin suckers as necessary for good canopy structure.

Follow general maintenace guidelines.

## Tree and Shrub Photo Pictorial and Individual Pruing Guidelines

Fothergilla gardenii
Dwarf Fothergilla

Prune in spring.

This shrub will bloom before leaf flush.

This plant should require little pruning with the exception of old canes. Depending on light conditions the plant may require some pruning to shape.

Follow general maintenace guidelines.

Hydrangea arborescens 'Annabelle'
Annabelle Hydrangea

This hydrangea blooms on new wood and should be cut back in the fall.

Remove dead canes and prune off approximatley 2/3 off the remainin canes.

As the plant matures canes should be selectively pruned to promote strong canes as flower heads can be large and weigh the branches down.

Follow general maintenace guidelines.

Hydrangea quercifolia 'Snow Queen'
Snow Queen Oakleaf hydrangea

Unlike the other hydrangea this one blooms on old wood and should be pruned mid-summer at the latest.

Selectively prune approximately 1/3 of the canes down to the ground. This will allow for some old growth to remain but open the canopy up for new growth to continue a strong blooming plant.

Follow general maintenace guidelines.

## Tree and Shrub Photo Pictorial and Individual Pruing Guidelines

Ilex Glabra 'Densa'
Densa Inkberry Holly

Prune in winter.

This is a great evergreen shrub for moist areas however if not pruned correctly it can get leggy. Leave canes up for winter intrest and in late winter prune back to force out new growth. Prune back no more than 1/3 of the plant and stagger cuts for a less sheared look.

Follow general maintenace guidelines.

Ilex verticillata 'red Sprite'
Red Sprite Winterberry Holly

Prune in late winter or early spring.

Remove up to one third of the oldest or most poorly performing branches down to the crown of the plant.

Follow general maintenance guidelines.

Itea virginica 'Henry's Garnet'
Henry's Garnet virginia Sweetspire

Prune in late winter or early spring.

The tree regularly sprouts secondary branches thus pruning should be specific to propmote strong leaders a avoid a lot of stubby secondary branches.

Follow general maintenace guidelines.

Viburnum trilobum
High Bush Cranberry

Prune in late winter or early spring.

Similar to other oaks, bottom branches may need to be pruned to allow for views within the site.

Prune for shape when young to promote strong form with age.

Follow general maintenace guidelines.

## US EPA INVASIVE PLANTS IN THE MID-ATLANTIC STATES

Lythrum salicaria
Purple loosestrife

An invasive in wet areas this plant is most likely to be found in the rain garden area and must removed immediately.

Hand pulling when young is best, before seeds form.

Young leaves can be recognized by their rough foliage and serrated edges.

See maintenance guidelines for spray alternatives

Bamboos

More typical in residential areas but this plant may appear at the site.

Bamboo plants have a strong root system and can be hand pulled but care must be taken so all of the plant is removed or else it will return and spread rapidly.

See maintenance guidelines for spray alternatives

Miscanthus sinensis
Chinese silver grass

This plant is used heavily in the ornamental industry. Although it does not usually migrate far, once in a planting bed it can spread.

The young plants can be recognized by their thin grass like foliage.

To distinguish the plant from other planted grasses look for a characteristic stripe down the center of the leaf blade. If left to grow a major identifying factor will be the plume heads in fall.

Even if a volunteer this plant is often left as people find it pretty. Do not let grow and hand pull.

See maintenance guidelines for spray alternatives

US EPA INVASIVE PLANTS IN THE MID-ATLANTIC STATES

Berberis thunbergii
Japanese barberry

This plant is quite common and often planted in the landscape trade.

Young plants can have red or green leaves but both have thorney stems. If left untreated mature plants will produce berries in wintertime.

Seedlings should be hand pulled and roots must be removed.

Ligustrum species
Privets

This plant can appear similar to some of the shrubs installed at Shoemaker Green but can be distinquished a little its glossy green leaves.

Hand pull saplings.

See maintenance guidelines for spray alternatives

Euonymus alata
Burning bush

Burning bush is another widley used landscape plant that is invasive.

Its recognizable by its distinct leaflets and corky bark.

Hand pull saplings.

See maintenance guidelines for spray alternatives

## US EPA INVASIVE PLANTS IN THE MID-ATLANTIC STATES

Pyrus calleryana 'Bradford
Bradford pear

Commonly planted in the industry this tree is a prolific re-seeder.

Small saplings can be recognized by the straight wood trunks and glossy bark. Leaves are very glossy and pear shaped. The plant flowers with white blooms in the spring and small fruit in the fall.

Hand pull saplings

See maintenance guidelines for spray alternatives

Acer platanoides
Norway maple

A prolific reseader in urban areas.

This plant is often confused with native maples. It can be easily be identified by the white sap that exudes from the leaf blade when pinched off.

Hand pull sapplings.

See maintenance guidelines for spray alternatives

Paulownia tomentosa
Princess tree

A regular re-seeder in urban areas, it can be difficult to recognize as a sappling.

It is a tree that will ultimately get 40-50 ft so if gone unrecognized will quickly form a sappling of height that can be recognized and removed.

Hand pull sapplings.

See maintenance guidelines for spray alternatives

US EPA INVASIVE PLANTS IN THE MID-ATLANTIC STATES

Albizia julibrissin
Mimosa tree

This invaisive tree is easily recognizable at the seedling stage. Look for a unique multi-leaflet pattern and soft textured leaflets.

Hand pull saplings.

See maintenance guidelines for spray alternatives

Lonicera species
Bush honeysuckle

Lonicera japonica
Japanese honeysuckle

Honeysuckle is invasive in two forms a bush and a shrub. None of the plantings at Shoemaker green will look very similar so seedlings can quickly be identified by their symmetrical leaflets.

The vine type can be recognized by red its red stems. There are native forms of honeysuckle that can be confused with the invasives but none were planted at Shoemaker Green.

Hand pull saplings.

See maintenance guidelines for spray alternatives

Hedera helix
English ivy

Ivy typically migrates from residential areas and can be recognized by its triangular leaf shape and dark green foliage.

Hand pull.

See maintenance guidelines for spray alternatives

## US EPA INVASIVE PLANTS IN THE MID-ATLANTIC STATES

Celastrus orbiculatus
Oriental bittersweet

This invasive is a vine that produces berries in the fall.

The seedlings should be hand pulled, if plant is in seed care should be taken so seeds don't disperse.

Hand pull and let dry to die.

See maintenance guidelines for spray alternatives

Ampelopsis brevipedunculata
Porcelainberry

Also a vine this plant produces orange berries in the fall.

The seedlings should be hand pulled, if plant is in seed care should be taken so seeds don't disperse.

Hand pull and do not put in burn pile if seeds are still viable.

See maintenance guidelines for spray alternatives

Wisteria sinensis, Wisteria floribunda
Chinese and Japanese wisterias

Also a vine this plant is widely used for its purple blooms.

Seedlings can be recognized by the long leaflets.

Hand pull and let dry to die.

See maintenance guidelines for spray alternatives